NAVAL AIR WARFARE CENTER TRAINING SYSTEMS DIVISION

2022

RESEARCH COMPENDIUM

TRAINING | HUMAN PERFORMANCE | MODELING & SIMULATION

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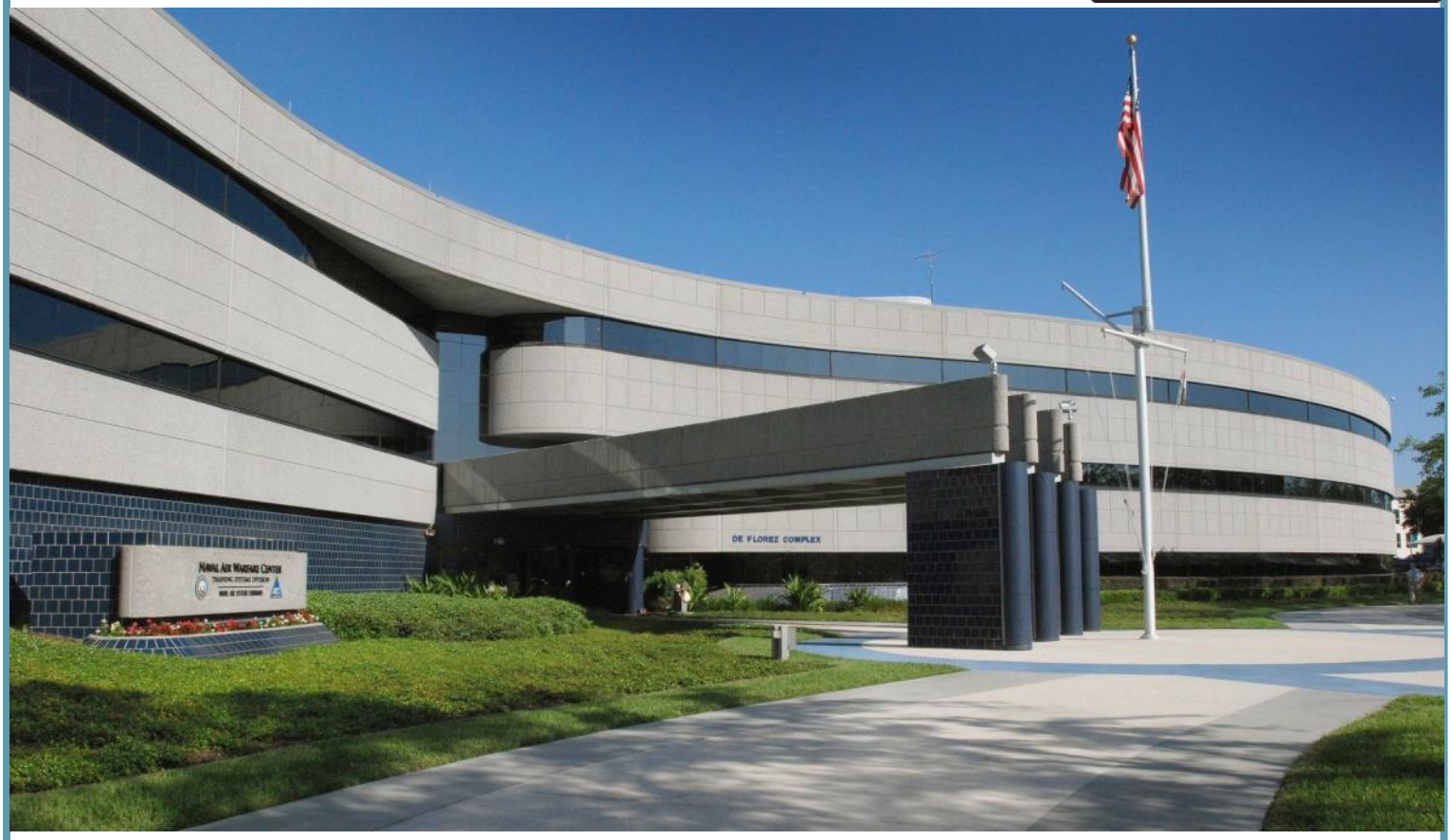
NAWCTSD

Research Mission

- Plan and perform a full range of **research and development,** in support of **Naval training systems** for **all warfare areas** and **platforms**
- Continue to expand the **Naval technology base**
- **Transition results** to the **Fleet** and other customers

View the Research Compendium online: https://www.navair.navy.mil/nawctsd/

RESEARCH COMPENDIUM



The Naval Air Warfare Center Training Systems Division (Photo Credit: Doug Schaub)

2022 EDITION

NAVAL AIR WARFARE CENTER TRAINING SYSTEMS DIVISON

Training ● Human Performance ● Modeling & Simulation

Research & Development to Enable Fleet Success

S&T R&D Where the Mission Begins

View the Research Compendium online: https://www.navair.navy.mil/nawctsd/

A Message from Our NAWCTSD Leaders: Science & Technology to Enable Fleet Success

Captain Dan Covelli USN
Commanding Officer

John Meyers
Executive Director

At NAWCTSD, we conduct research to understand and **improve individual, team, and multi-team learning** and performance. We develop education, training methods, and tools to **reduce training time and maximize transfer of knowledge,** utilizing emerging findings in the **Science of Learning** to enable Fleet success.

OUR MISSION

To be the principal Navy center for research, development, test and evaluation, acquisition and product support of training systems, to provide inter-service coordination and training systems support for the Army, Marine Corps, and Air Force, and to perform such other functions and tasks as directed by higher authority.

Near-term Fleet Science & Technology focus areas includes: distributed, Live, Virtual and Constructive (LVC) training; adaptive training; human performance modeling; measurement and assessment; virtual reality and augmented reality training technologies; cyberwarfare and electronic maneuver warfare training; and rapid prototyping of training technologies.

Our research efforts focus on where the mission begins—where the body of knowledge of human performance and training is expanded, where innovations are developed, concepts are established, and prototypes are demonstrated.

We promote experimentation and creativity, and we encourage our people to challenge basic assumptions. We are open to reinventing ourselves based on new knowledge and understanding. To do this, we work to consistently seek Fleet input and feedback on our projects.

Our ultimate goal is that our training solution innovations are transitioned to the Fleet as quickly as possible to improve warfighter readiness. As part of this process, we lean forward to deliver Fleet prototypes for selected projects that show the greatest promise for transition and Fleet impact.

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William Zeller, Director
Research & Technology Programs Office

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NAWCTSD is a key warfare center laboratory for training systems and human performance. The primary goal of our researchers is to explore and develop advanced technologies and methodologies to ensure that the Fleet of tomorrow has the skills, training, and equipment it needs to enable success against current and future threats.

OUR VISION:
To merge behavioral, cognitive, and engineering sciences to produce effective training solutions and systems, exploiting technology to improve performance, reduce risk, and reduce cost.

OUR STRATEGY:
Partnering with and leveraging work at universities, industry, and other Government laboratories, to provide advanced technologies that transition into operational use.

Our research focus areas align to our CORE CAPABILITIES:

1. Human Systems Engineering, Integration, and Acquisition
2. Optimized Human Performance and Decision Support
3. Advanced Training Systems Technology
4. Human Systems Analysis, Design, and Evaluation

The Naval Air Warfare Center Training Systems Division (NAWCTSD) is the Navy's source for a full range of innovative products and services that provide complete training solutions. This includes research and development in human performance, learning, advanced technologies through training system acquisition, and life-cycle support.

NAWCTSD's research mission is to plan and perform a full range of directed Research and Development (R&D) in support of Naval training systems for all warfare areas and platforms, to maintain an expanding Naval-critical technology base, and to transition research results to the Fleet and other customers.

Dr. Melissa Walwanis
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Principal Program Manager
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The Department of the Navy's (DON) Science and Technology (S&T) program includes Basic and Applied Research (BA1 and BA2), and Advanced Technology Development (ATD) (BA3) that is funded and managed by the Office of Naval Research (ONR). The Naval S&T Strategic plan describes how ONR will enable the future operational concepts of the Navy and Marine Corps.

NAWCTSD's S&T Program primarily focuses on supporting the Naval Aviation Enterprise's (NAE) Naval Warrior Performance Science and Technology Objectives (STO) that are detailed in the NAE STO document dated April 2014. The NAE STOs directly align to support the Naval S&T focus area called Naval Warfighter Performance. Other NAE STOs addressed by the S&T project portfolio include: Strike Operations, Undersea Warfare, Information Dominance, and Enterprise and Platform Enablers.

The **Naval Innovative Science and Engineering (NISE) Program** was created under Section 219 of the Duncan Hunter National Defense Act for Fiscal Year 2009. It is intended to promote and maintain the scientific vitality of Naval laboratories by funding innovative in-house research in support of military missions, the transition of technology development programs into operational use, and workforce development activities. There are three categories of NISE projects.

The **Basic and Applied Research category** consists of in-house research projects to explore the fundamental aspects of military relevant phenomena and determine ways in which those phenomena can best be used by the military.

The **Workforce Development category** of projects is intended more explicitly to build the capability of Naval labs through personnel training and laboratory capability development.

Finally, the **Transition category** provides funding for pre-Milestone A bread board or brass board demonstrations and prototyping efforts to demonstrate critical performance parameters of key technologies.

John Hodak
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Small Business Research Program Manager

The Small Business Innovation Research (SBIR) and Small Business Technology Transition Research (STTR) programs are divided into three phases. Phase I is to determine the scientific or technical merit and the feasibility of new and innovative ideas. Successful completion is a prerequisite for funding in Phase II. This second phase is the principal R&D effort. Companies are asked to consider the commercial possibilities of the proposed R&D, and encouraged to obtain a private commitment for follow-on funding to pursue their commercial potential. Phase II is expected to produce a well-defined deliverable, such as a prototype or process that the Navy is interested in acquiring. Phase III requires the use of non-SBIR/STTR capital by the small business to pursue commercial applications of the R&D and to deliver products to the Navy. The SBIR and STTR programs differ only in the fact that small companies perform exploratory R&D in partnership with universities and larger nonprofit research institutions in the latter program and by themselves in the former.

Technology Transfer Program Manager

The NAWCTSD Technology Transfer Program operates under the Federal Technology Transfer Act, related laws, executive orders, directives, and guidance. The anticipated benefits of sharing the results of Navy research and development (R&D) with public and private research organizations are: improved national, state, and local training and education; new commercial products and additional national employment opportunities; access to federal Government subject matter experts (SME) and resources, and feedback on R&D products that can be used to improve future Government systems.

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Human Research Protection Program Chair

The Human Research Protection Program (HRPP) implements NAWCTSD's policies and procedures to protect human subjects involved in research conducted by, for, or through NAWCTSD. Our Institutional Review Board (IRB) was established in 2000 and has the responsibility to protect the rights and welfare of human subjects at potential risk in research projects. NAWCTSD maintains a DoD-Navy Assurance to conduct research.


RESEARCH
PROJECT
SUMMARIES

CORE CAPABILITY 1:
HUMAN SYSTEMS ENGINEERING, INTEGRATION, AND ACQUISITION

The successful acquisition of training and crew system solutions is highly dependent upon the tailored application of Human Factors, Systems Engineering, and Human Systems Integration (HSI) strategies and processes throughout the acquisition life-cycle. The Department of Defense's (DoD) acquisition policy goal is to optimize total system performance while minimizing the cost of ownership through the development and acquisition management by applying HSI elements to acquisition systems.

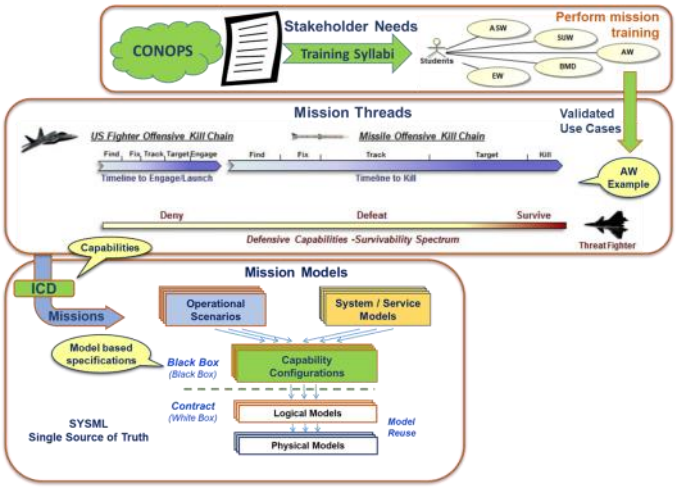
HSI establishes the technical framework for delivering crew and training system capabilities to the warfighter. It ensures the effective development and delivery of capabilities through the implementation of a balanced approach with respect to cost, schedule, performance, and risk using integrated, disciplined, and consistent systems engineering activities and processes throughout the acquisition life-cycle to guide knowledge-based product development that demonstrates high levels of performance, protection, and sustainment before significant commitments are made.

The following technology area comprises this Core Capability: Research, Design and Development of Integrated Human System products.

MISSION MODEL ARCHITECTURE FOR AIR WARFARE (WFDSG-21-027)

OBJECTIVE

To explore repeatable practices for modeling missions using SysML and a systems-of-systems architecture. To develop sample Air Warfare (AW) and Maritime mission models for demonstrating the exploration of outcomes.



PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD-SG

POINTS OF CONTACT

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DESCRIPTION
Model-Based Systems Engineering (MBSE) is an emerging discipline ideally suited for blueprinting architectures of complex systems and operations. With MBSE, the model is independent of the views a designer creates for stakeholders, and when the model changes, each view is automatically updated to reflect the changes. MBSE provides the ground truth for not only the design of systems and operations, but also for conducting analyses, verification, and validation. A primary goal of MBSE is to provide better requirements for creating specifications that contractors can use for developing systems. A primary benefit is putting requirements into one place and then connecting those requirements with desired capabilities needed for making decisions.
A goal for developing a mission model architecture is to initiate the ability to draw from a portfolio of ready-to-go missions in order to create a training environment that enables forces to prepare for an ever-changing combination of military engagements.

NEED
NAVAIR is going through a transformation from using documents that describe systems, to models that document systems. Having a generic set of practices for developing a hierarchical architecture for modeling missions would accelerate NAVAIR's modeling maturity at a time when it is needed most.

BENEFITS
With NAVAIR's emphasis on Model Based Systems Engineering (MBSE) for acquisition, having a mission model template based on the Department of Defense Architecture Framework would simplify integration and reuse not only across NAVAIR, but across SYSCOMS and possibly the other services.

STATUS
COMPLETED TASKS:

- Explored enterprise frameworks and industry model methodologies
- Selected INCOSE's Object Oriented Systems Methodology (OOSEM) & and the DoD Architecture Framework (DoDAF)
- Example Search and Rescue (SAR), Air Warfare (AW), and Anti-Submarine (ASW) mission threads explored
- Explored visualization solutions à Identified Architecture Framework Simulation (AFSIM) as a likely candidate
- Developed a generic Find-Fix-Track-Target-Engage-Assess mission thread model for one-on-one AW engagements
- Developed model of MH-60R that applies the Find-Fix-Track-Target
- Engage-Assess mission thread to find a submarine
- Initiated the development of solution neutral ROC POE based AW and Maritime MBSE models

MILESTONES

- FY21: Determine an approach for developing a mission model architecture
- FY22: Develop generic AW and Maritime mission behavioral models

MULTI-INTEGRATED DOMAIN ADMINISTRATIVE SUPPORT SOLUTION (N182-104)

OBJECTIVE

Design and develop a cross-domain solution (CDS) technology that allows a centrally located system administrator to disseminate network configuration information to multiple associated networks.

The Department of Defense effort to enhance and combine its computer networks to improve capability and reliability.

PROJECT DURATION

SEP 2018 - NOV 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

POINTS OF CONTACT

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Javier Spear (Co-TPOC)
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DESCRIPTION

One of the core security features of distinct information networks is that they are separate from other computer networks. This is primarily implemented to ensure that if one is compromised, the other remains unaffected as access to the network is limited and restricted by an administrator. This effort focuses on designing, developing, and demonstrating the feasibility of a proof-of-concept cross-domain administrative solution and network communication between trusted and untrusted networks.

NEED

Although the cyber security benefits of individual networks are clear, there is a desire for a secure CDS to allow a central system administrator to manage multiple networks. Cross-domain solutions provide the ability to transfer information between two domains with different security levels that are isolated from each other. Currently, each network administrator must set up separate instances for their own respective domains, which poses software-related concurrency challenges. The desired solution is envisioned as a standalone solution, or a technology that can be added to an existing cross-domain solution for network communication between trusted and untrusted networks. Key factors of an envisioned solution include the scalability of architecture and the supportability of the device.

BENEFITS

Having the ability to manage all domains with a single cyber security solution (through a specialized guard) would significantly lessen both the initial acquisition and sustainment costs of any procurement that had the requirement for multiple classification levels. or design solution tradeoffs of comparative technologies.

STATUS

NAWCTSD personnel conducted a Phase 2 evaluation at the end of 2019, based on the results of the Phase 1 base and option work. The cross-code project team determined that the contractor should be awarded the Phase 2 base period to conduct additional prototyping work. The Phase 2 effort is underway in which the contractor and Navy are working together to modify and implement CDS solutions deemed feasible from Phase 1 work.

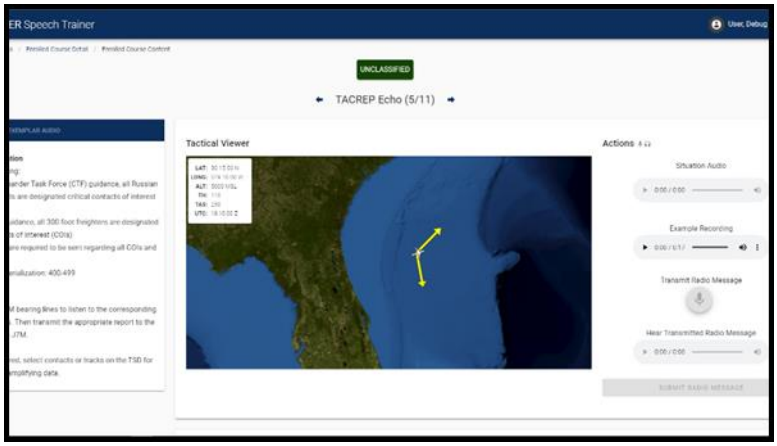
MILESTONES

- A single contractor was selected for Phase 2 award
- Cross-code project team (research psychologists and interoperability engineers) monitoring was completed via bi-monthly progress reports and periodic status updates
- The contractor is currently working on the Phase 2 effort
- Prototype CDS solutions expected by the end of the Phase II (Nov 21)

RADIO OPERATIONS GUIDANCE AND EDUCATION RESOURCE (ROGER) TEST & EVALUATION (219RPC-21-009)

OBJECTIVE

Facilitate ROGER development and transition efforts by conducting fleet experimentation and demonstrations to include: human factors analysis, usability analyses, and training effectiveness evaluations. Results from formal analyses will inform future acquisition on the benefits of the technology to quantify return on investment for transition.



ROGER Prototype User Interface, Showcasing Intermediate Course Concept

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: RPC

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DESCRIPTION

ROGER is a web-based radio communications trainer for the Maritime Community. Throughout this effort a series of fleet demonstration and experimentation events will be conducted on the ROGER prototype to evaluate the training capability. The initial prototype exists on stand-alone laptops for demonstration and experimentation with the Maritime Patrol and Reconnaissance Aircraft (MPRA) community. Fleet users will have the opportunity for hands-on demonstration, and a time to provide feedback to the team for further iterations of the system. The results of experimentation will provide human factors and training effectiveness data to inform the system design and identify capability improvement areas. Further, the team will work with the end user community to develop concept of operations and pre-training needs for define how to successfully implement with the program of records course of instruction.

NEED

The MPRA community has no existing curriculum or dedicated training capabilities for training radio communications, and as such has cited a need for radio communications training. The primary Fleet impact of this effort is to provide quantitative data to the acquisition program of record on the benefits of the technology to closing skill gaps associated with multi-domain and joint communication via a designated radio communication-based training system.

BENEFITS

Testing will focus on reliability of component technologies, as well as the effectiveness of the ROGER training solution to provide an instructor-in-the-loop and/or instructorless training system that students can interact with to learn how, when, and why to perform certain tactical radio calls. Through quantitative analysis of the effectiveness of the technology, arguments can be formulated to execute an accelerated acquisition to deliver this emerging technology to the Fleet.

STATUS

Small-scale survey sent to naïve users, demonstration at training day events with VP-30, Initial usability testing and training effectiveness evaluation (TEE; 15 students, 3 instructors); Investigated un-facilitated debrief literature to inform debrief human factors guidance; Defined data collection plans for speech system reliability, and investigated options for participant payment for FY22; Coordinating for possible FY22 data collection at ANTX or other event; Drafted long range training effectiveness plan options. Products Developed: Prioritized list of prototype modifications provided to design and development team for iterative updates to be made and tested with end users.

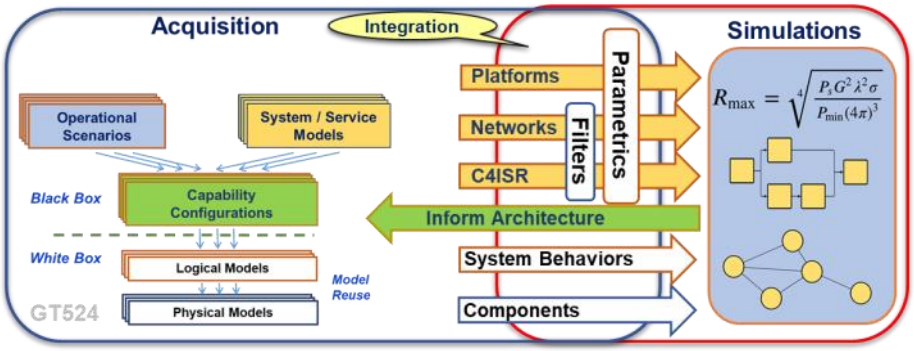
MILESTONES

- Year 1: IRB approval, Human Factors analysis of system
  - ◊ Conducted usability and initial training effectiveness data collection with instructors and students to inform future design focus areas (AUG 2021)
- Year 2: Usability and effectiveness study results and documentation and Concept of Operations documentation

SIMULATION WITHIN SYSML FOR TRAINING SYSTEMS (TR-21-027)

OBJECTIVE

To develop employees in the application of design patterns for integrating simulation within SysML.



PROJECT DURATION

OCT 2020 - SEPT 2021

SPONSOR

NAWCTSD Special Programs | PMA-205

POINTS OF CONTACT

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DESCRIPTION

There are several sources for learning SysML available to NAWCTSD employees, each having its own focus area. This effort unifies learned concepts and focuses them in areas that would expand NAWCTSD's capability to apply SysML in a consistent and reusable manner for simulating systems. The training for this effort complements what has already been taught and comes directly from the suppliers of the tools NAVAIR is already using. This compilation of courses channeled several disparate model-based training efforts into focused model-based practices for the purpose of accelerating the transition to SysML. The training consisted of modeling techniques that are integratable to be used as a basis to develop an approach for integrating simulation within SysML.

NEED

There is a growing demand across several programs for capable modelers that can integrate simulation. This effort has accelerated the development of skilled employees to meet the demand.

BENEFITS

Supplemented NAVAIR SET SysML courses with a focus on developing modeling practices specific for training systems

STATUS

Three Four courses were completed to meet requirements: MATLAB Fundamentals for Aerospace Applications by MathWorks : This 3-day course provided a comprehensive introduction to the MATLAB® technical computing environment for aerospace engineers. Themes of data analysis, visualization, modeling, and programming were explored with an emphasis on practical application to aerospace engineering.

Simulink by MathWorks: The Simulink for System and Algorithm Modeling 2-day course offered online demonstrates how to apply basic modeling techniques and tools to develop Simulink block diagrams. Topics included: Creating and modifying Simulink models and simulating system dynamics; Modeling continuous-time, discrete-time, and hybrid systems; Modifying solver settings for simulation accuracy and speed; Building hierarchy into a Simulink model; Creating reusable model components using subsystems, libraries, and model references.

Simulation by NoMagic: The Simulation of System Behavior 3-day course covered the fundamentals of using the Simulation Toolkit to execute Parametric Diagrams, behavior diagrams and system models using SysML and Executable UML. It included lectures, hands-on practical exercises and best practices using Cameo Simulation Toolkit.

Electromagnetic Warfare Modeling using Matlab and Simulink by GTRI: Techniques for modeling and simulation (M&S) of radio-frequency (RF) electronic warfare (EW) systems were developed. An EW engagement model was developed to illustrate the interaction between radar and jamming signals and the impact in radar detection and tracking. In addition, several EA techniques were introduced and modeled, and the effects of radar performance were explored.

MILESTONES

- 1st Quarter - Scheduled courses
- 2nd - 4th Quarters – Arranged and completed the courses

SURVEY RESEARCH TO SUPPORT THE USE OF SYNTHETIC CREWMEMBERS IN MARITIME AVIATION TRAINING

OBJECTIVE

Conduct survey research with the end user community to focus on (1) understanding trainee expectations of interacting with synthetic crewmembers, (2) understanding shifting trainee feedback needs and (3) providing recommendations for transitioning students from the current training environment to an environment that utilizes automated technologies.

P-8A student during a part-task training exercise

PROJECT DURATION

JAN 2020 - JAN 2021

SPONSOR

Naval Aviation Training Systems and Ranges Program Office, PMA-205, Air Warfare Training Development

POINTS OF CONTACT

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DESCRIPTION

Synthetic agents seek to solve a long-standing initial training challenge – how to train a single trainee in a task that requires a crew or group to complete it. Typical solutions include rotating trainees, or using contractor or instructors as role players. However, these solutions can be inefficient and/or costly to implement. With recent technological advances in speech recognition, the feasibility of incorporating synthetic role-playing into a dynamic initial training has increased.

NEED

The development and inclusion of technologies within training happens before the ramifications of augmenting technology is fully understood. There is a need to further assess the human component in a human-machine team. A long-standing challenge of utilization of new technologies is user acceptance and user training. When changing the training paradigm to include synthetic crew members, it is important to appropriately train and transition students (and instructors) from the current technologies to the newly developed ones.

BENEFITS

Intelligent, speech-activated role player agents include autonomous, interactive crewmembers that are capable of supporting and providing information to, and interacting with the Tactical Coordinator or TACCO, to support TACCO initial training within the P-8A Part Task Trainer (PTT). The results of this effort will inform best practices for utilizing synthetic agents in a training program, and student perceptions of these changing training technologies.

STATUS

In FY20, surveys were developed to distribute to both P-8A Poseidon instructors, as well as students (NFOs, AWOs, and EWOs). Data collection and analysis has been completed. Results indicate some hesitation and some excitement on behalf of students and instructors regarding the use of synthetic agents. Best practices and recommendations for transitioning students to a synthetic agent training environment are being generated and shared with the community.

MILESTONES

- Survey creation completed APR 2020
- Data collection completed SEP 2020
- Final Technical report submitted JAN 2021
- I/ITSEC paper detailing the results of the effort accepted and will be presented in DEC 2021

CORE CAPABILITY 2:
OPTIMIZED HUMAN PERFORMANCE AND DECISION SUPPORT

Current and future Naval systems are not only dependent on the qualities of the systems and the performance of their operators, but are also highly dependent upon the interaction between the human and the system. Failure to effectively integrate the human and the system invites mission failure. It is routinely reported that 70-80% of all aviation and other mishaps trace back to human error in some fashion.

The overwhelming majority of these errors are related to inaccurate decisions, judgments, and perceptions, attributable to inadequacies in the systems design or decision-support capabilities. The extent to which those same design and/or decision support inadequacies contribute to operational inefficiencies or outright decrements is not as clearly quantified, but is expected to be profound.

Human Performance refers to the range of perceptions, decisions, and actions that an individual or team carries out in the context of performing a task. The underlying detail in each of these actions traces back to the design of systems and the training of operators. Human Performance Assessment (HPA) focuses on the ability to accurately measure and analyze task performance at different levels that include individuals, teams, multi-teams, and organizations. HPA can be conducted across multiple domains and tasks, ranging from simple procedural skills to complex cognitive skills, such as tactical decision-making, and is an integral part of Human Performance Modeling (HPM). Measurement technologies encompass neurocognitive as well as other physiological measures or indices. Better understanding of such measures in the context of training or operational tasks will serve both to expand this technical area and to enhance warfighter performance and effectiveness.

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While there is already a clear adverse impact resulting from the lack of/ flawed human systems design and decision support, there is also a significant concern that this will be rapidly exacerbated due to the overwhelming amount of data being collected and available in a timely fashion. For human decision-makers to be effective in these information-rich environments, "they must be able to access the data necessary to make a decision when, where and in a manner that addresses the need. The data must be integrated and organized so that they become useful information to the user" (Morrison et al., 1998, p. 375). The challenge of integrating the human and system can be parsed into four separate pieces: 1) human factors engineering—which is required for the system to be used effectively by the human operator, 2) Human Machine Interface (HMI) specifically developed to supplement the human's ability to process, infer, and decide in real time actions based on system-provided information, 3) developing the requisite training materials of modes of presentation to optimally use the information to make and implement better, faster decisions, and 4) automation to perform functions without direct human intercession.

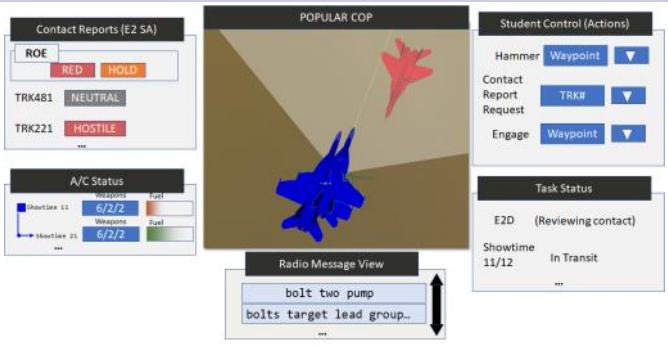
The following Technology areas comprise this Core Capability:

- Human-Machine Interfaces (HMI)
- Human Performance Measurement and Assessment (HPM/HPA)
- Training Methodologies for Distributed Team Competencies
- Advanced Instructional Techniques
- Applied Human Behavior Modeling

PEDAGOGICAL PRACTICE FOR LEARNING, ASSESSMENT, AND REMEDIATION (POPULAR) (N15A-T013)

OBJECTIVE

Develop the capability to automatically assess and generate scenarios to remediate skills and readiness for unit-level training events. Ultimately, POPULAR will enable automatic, adaptive assessment and remediation capabilities for preparing trainees for Live, Virtual, and Constructive (LVC) training and operational events.



POPULAR common operating picture graphical user interface

PROJECT DURATION

OCT 2021 - SEPT 2023

SPONSOR

PMA-205 | Small Business Innovation Research

POINTS OF CONTACT

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DESCRIPTION

Description: Upon arrival for an Air Wing Fallon training event, squadrons frequently spend a fraction of early events working through basic procedures that need not be completed on-range. Given the increasing use of simulation training, this effort will research and develop a system focused on autonomous, diagnostic pre-training simulation exercises. The overall system will deliver simulation exercises designed to assess skill and readiness, diagnose potential reasons for skills gaps, and then recommend additional training/practice scenarios targeted to fill skill gaps and the underlying causes for deficits.

The technology addresses a gap related to pretraining simulation exercise assessments. The status of the technology under development is a working prototype unit that has undergone engineering testing to validate the algorithms and software required for further development. The new work accomplished under this Phase II.5 AT will include conducting research and testing to prepare the technology for acquisition by PMA-205 Training Systems Program.

NEED

Performance assessment of Carrier Airwings (CVWs) during Air Wing Fallon relies solely on qualitative instructor assessments presenting resource challenges with manpower, training time for instructors, standardization of metrics and feedback, and overall accuracy of recorded data. This practice requires instructors to pull data from multiple, disparate, often stove-piped systems and manually synthesize these data to conduct debrief and provide assessments which is time intensive.

To mitigate these challenges and increase proficiency, readiness, and overall mission performance the technology under development provides architecture that will indicate and record the occurrence of key mission level events. The sequence and timing of events, along with relevant metadata, can be used to compare the pilot's performance to established standards (and eventually the performance of other individuals throughout the workup cycle). Pretraining assessments will provide squadron commanders a snapshot of personnel readiness prior to the commencement of airwing level training, potentially before leaving home station. Commanders can introduce mitigation and readiness strategies with enough time to implement corrective actions.

BENEFITS

POPULAR offers significant benefit to the Navy. Its simulation exercises will serve both to refresh basic skills and to estimate proficiency of incoming squadrons, enabling Fallon staff to prepare for and to tailor initial live events to the level of readiness of the arriving squadron. Secondarily, these simulation exercises may be used to remediate skills and to thus increase actual readiness for Fallon exercises, as well as to provide assessments in advance of initial exercises. Sustainment of the capability can be supported by simply providing updated scenarios that meet the current/future Fallon readiness criteria. Future scenarios can be developed manually or constructed via scenario generation/machine learning methods developed under this effort, reducing the reliance Subject Matter Experts (SMEs) to encode performance data or direct a simulation exercises manually.

STATUS

In FY21, the POPULAR IPT: 1) Conducted initial site visit with NAWDC for concept socialization and identification of operational user communities, 2) Conducted requirements analysis activities to gauge user interest, 3) Held discussions with N5 STRIKE to develop initial user stories, 4) Reviewed literature surrounding mission planning and strike fighter tactics, 5) Began development of plugin extensions to Next Generation Threat System (NGTS) to enable students to experience familiarization training with a standard suite of Naval aviation training scenarios.

MILESTONES

- Identified N5 STRIKE as initial user community of interest.
- Leveraged available NAWDC training, documentation, and publications to conduct task analysis and decomposition of training needs.
- Defined requirements around initial scenarios of interest including Defensive Counter Air (DCA).
- Began initial technical integration with Next Generation Threat System through integration with the simulation core.

ADAPTIVE TRAINING SYSTEM FOR MAINTAINING ATTENTION DURING UNMANNED AERIAL SYSTEMS (UAS) OPERATIONS (N162-090)

OBJECTIVE

The purpose of this effort was to develop an innovative and adaptive training system for Unmanned Aerial Systems (UAS) operators to maintain attentiveness during the long shiftwork associated with extended UAS missions. The initial call (for proposals) was made for cost-effective, computer-based, simulation training solutions that are able to adapt to the 1) learning characteristics of different individuals, 2) affordances inherent in UAS, and 3) specific details involved with different missions.

Image courtesy of TiER1 Performance Solutions, Copyright 2018. Includes U.S Navy Photo 140918-N-UZ648-008

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PROJECT DURATION

OCT 2016 - SEP 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

The work shifts for UAS operators can sometimes approach 12 hours in length. Such shiftwork is associated with higher fatigue levels, degraded task performance, and higher error rates. As UAS are used with increasing frequency, it becomes even more critical for UAS operators to maintain their attention for longer periods during lengthy missions. However, there are currently no training systems that focus on attention. This research aims to develop tailored adaptive training techniques to minimize the issue of channelized attention.

NEED

Channelized attention occurs when all of an individual's cognitive resources are focused on one aspect of the environment, causing other equally important cues to be missed. Investigations of UAS mishaps have implicated channelized attention as a likely contributor to mishaps with larger UAS. Thus, it is critical to provide training for UAS operators on how to maintain attention over extended periods of time.

BENEFITS

Research on attentional training has indicated that it is possible to train attention *and* create effects that transfer to tasks after training. Moreover, attentional training may be more effective if it is adaptive. Adaptive training (AT) is broadly defined as any instruction that is tailored to an individual trainee's strengths and weaknesses, varying the training experience from one individual to another, based on task performance, aptitudes, or test scores. The goal of AT solutions is to provide the effectiveness of one-on-one tutoring through computer-based training that does not require an instructor in the loop. Thus, such training can possibly reduce the likelihood of UAS mishaps via a cost-effective method.

STATUS

The selection team approved two companies (i.e., Adaptive Immersion Technologies [AIT] and TiER1 Performance Solutions [TiER1]) to proceed to the Phase II Option period for their systems. The AIT-developed Sustained Attention Training in Unmanned & Remote Navigation (SATURN) system targets the attentional training of air vehicle operators. In contrast, Tier1's Attentional Trainer To Improve Control of Unmanned Systems (ATTICUS) focuses on sensor operators. During this period, both companies continued to make refinements to their systems. Although COVID-19 stymied much of the anticipated progress during FY20, AIT continued to make considerable progress on prototype development, including scenario definitions and implementation. Likewise, despite the pandemic, TiER1's data collection efforts are underway, to assess the validity of ATTICUS in improving the attentional skills of UAS operators.

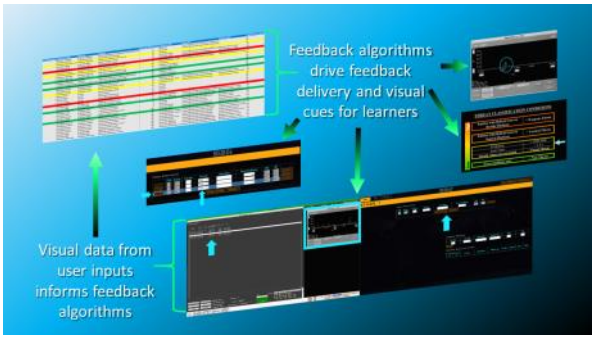
MILESTONES

- Selected 4 companies (from >25 proposals) for the Phase I Base period.
- Selected (using gated approach) two companies to proceed with the Phase I Option, Phase II Base (abbreviated), and Phase II Option periods.
- Both companies successfully completed the SBIR Transition Program in April 2019.
- Sebok, A., Walsh, M., Wickens, C., Andre, T., Kreischer, N., Pei, L., Bowens, L., & Landsberg, C. (2019). Development of attentional skills training for operators of unmanned aerial systems. Proceedings of the Human Factors and Ergonomics Society 2019 Annual Meeting, pp. 2161 – 2165.
- Recently, Tier1 began data collection for the ATTICUS training effectiveness study, and the AIT team made significant progress in developing the mission platforms for SATURN.
- The important next step for Tier1 is to complete the study (e.g., data collection, analysis) to validate the use of ATTICUS in improving attentional skills. For SATURN, important next steps are to begin software development and commercialization efforts.

ENHANCING ADAPTIVE TRAINING ALGORITHMS WITH FINER-GRAINED VISUAL DATA

OBJECTIVE

This effort will develop passive, real-time image analysis methods to support advanced instructional and diagnostic feedback algorithms in adaptive training systems and evaluate their effectiveness for training. We will develop this technology as a data source for adaptive training algorithms, incorporate the information in adaptive training algorithms, and empirically evaluate its effectiveness for learning when compared to the current state-of-the-art in this domain. Our deliverables will be a software capability for real-time image analysis, definition, implementation and validation of feedback algorithms using visual data and compilation of our results in a technical report.



Conceptual Diagram for Interplay of Feedback Algorithms, Visual Data, and Feedback Interventions

PROJECT DURATION

OCT 2021 - SEPT 2023

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR

POINTS OF CONTACT

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Jason Hochreiter (Co-PI)
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DESCRIPTION

This effort progresses the state-of-the-art in training by empirically examining the utility of passive visual analysis methods to enhance feedback provided to trainees. Many adaptive training systems "see what the user submits" to provide instructional interventions, but this effort will enhance adaptive training systems to "see what the user sees." The present effort will expand on our previous work with electronic warfare adaptive training systems to provide an enriched data source for the system's adaptive algorithms, enabling the system to provide instructional interventions in near real-time. In doing so, visual analysis supported feedback algorithms will grow closer to approximating the one-on-one learning experience, as it will be able to respond to the user's needs more rapidly.

NEED

The Navy's EW Wholeness campaign has emphasized the need for training that can "rapidly improve experience levels of current EW operators." Our previous work has shown that adaptive training systems can support this goal, and the current effort aims to extend this approach by enhancing adaptive training systems. The visual analysis techniques we are developing have the potential to provide timelier, relevant feedback to trainees, which should be beneficial for training.

BENEFITS

This research supports the Navy's goal to provide enhanced training to operators. This effort represents a novel application of an existing technology to enhance training, pushing the state-of-the-art forward. Additionally, image analysis methods are suitable for application in a wide variety of existing computer-based training platforms, provided the domain of visual data supplied by the platform is well defined. Therefore, the development and application of visual analysis techniques could benefit other domains that require Fleet operators to process similar data, such as, signal readings and parameter data. This research seeks to understand how best to implement visual analysis data into training feedback algorithms, which will help the Navy to build better training systems. The visual analysis techniques and algorithms developed for this project will immediately transition to a currently deployed system – the Submarine Electronic Warfare Adaptive Trainer.

STATUS

For FY22, the research team is developing passive visual analysis software as a data source for adaptive training feedback algorithms. While the software is being developed, the team will prepare an experimental plan to submit for Institutional Review Board approval. The purpose of this experiment is to compare visual analysis supported feedback algorithms against current state-of-the-art rule-based feedback algorithms, and a no-feedback control condition. The experiment is expected to commence in FY23. These data will be analyzed to evaluate the efficacy of visual analysis supported feedback algorithms.

MILESTONES

- Year 1:
  - Detailed Experimental Plan
  - IRB protocol approval
  - Finalized feedback algorithms
- Year 2:
  - Collect experimental data
  - Pre-transition computer vision feedback algorithms into latest prototype SEW-AT
  - Develop transition plan with transition customer
  - Conference paper/presentation acceptance

CLOUD-BASED AIR TRAFFIC CONTROL TRAINING SYSTEM (N211-010)

OBJECTIVE

Develop an innovative and cost-effective Cloud Based Air Traffic Control Training System that will provide ready relevant training and encourage student participation through gamification of learning arcade style activities, with integrated student and class metrics that can increase training efficiency.

200729-N-UJ449-1013 SIGONELLA, Italy (July 29, 2020) Air Traffic Controller 2nd Class Benjamin Colley, assigned to Air Traffic Control Sigonella, establishes communications with aircraft departing Aeroporto di Sigonella/Naval Air Station Sigonella, July 29. NAS Sigonella's strategic location enables U.S, allied, and partner nation forces to deploy and respond as required to ensure security and stability in Europe, Africa and Central Command. (U.S. Navy photo by Mass Communication Specialist 2nd Class Josh Coté)

PROJECT DURATION

JUL 2021 - JUL 2022

SPONSOR

Small Business Innovation Research (SBIR)

POINTS OF CONTACT

Beth Atkinson (PI)
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DESCRIPTION

This topic seeks to investigate a Cloud Based Air Traffic Control Training System that leverages ready relevant learning and game theory. The system should allow remote access to a wide range of exercises and resources for students, instructors, and management. Consistent with the Cloud First policy, agencies will use cloud infrastructure when planning new mission and support applications. Additionally, agencies will consolidate existing applications to help reducing training time. In addition, one of the focus areas is improving training quality.

NEED

Currently the Air Traffic Control community lacks the ability to train a team while at different locations. The development of an innovative and cost-effective Cloud Based Air Traffic Control Training System that can provide ready relevant training and encourage student participation through gamification of learning arcade style activities, with integrated student and class metrics that can increase training efficiency can address that need. This capability will provide a level of training fidelity that the community has not experienced while reducing training time and cost.

BENEFITS

The Cloud Based Air Traffic Control Training System should consist of networked Tower and Radar Trainer, and a Part-task computer based trainer that has access to training modules on the cloud. More specifically, this effort seeks to investigate a Cloud Based Air Traffic Control Training System allowing remote access to a wide range of exercises and resources for students, instructors, and management. The system should have the ability to remotely observe the simulator from anywhere in the world via the internet providing users the ability to simulate, simultaneously, operations of multiple Air Traffic Control (ATC) facilities such as multiple ATC approach control radars and multiple ATC towers operating in one given airspace. This ability should allow tower and radar controllers to simultaneously train using the same aircraft, handoffs, etc. to allow for a more realistic training scenario. Interactive development tools that allow for quick and easy creation of accurate scenarios can be immediately deployed to the cloud and used in full simulators and part task trainers in all locations.

STATUS

Topic was released as part of the 21.1/21.A topic call. Competitive source selection from initial proposals resulted in 3 Phase I awards. Vendors are exploring capability needs and refining system design concepts in preparation of submitting a Phase I feasibility report.

MILESTONES

- Phase I: Identify and demonstrate feasibility of a Cloud Based Air Traffic Control Training System that leverages ready relevant learning and game theory. Simulate, simultaneously, operations of multiple Air Traffic Control (ATC) facilities such as multiple ATC approach control radars and multiple ATC towers, operating in one given airspace. The Phase I effort will include prototype plans to be developed under Phase II.
- Phase II: Develop and demonstrate a functional Cloud Based Air Traffic Control Training System prototype with the ability to communicate via DoN Networks, the Navy Marine Corps Intranet (NMCI), the Outside Continental United States (OCONUS) Navy Enterprise Network (ONE-Net) and the Marine Corps Enterprise Network (MCEN). The prototype of the software technology that considers and adheres to Risk Management Framework guidelines to support cyber-security compliance in a lab or live environment. Install, integrate, test, train, validate and deliver the Cloud Based Air Traffic Control Training System prototype.

INVESTIGATION OF AERIAL VEHICLE OPERATOR (AVO) INTERFACES, INCLUDING INEFFICIENCIES, WORKLOAD, AND USABILITY

OBJECTIVE

This effort aims to investigate Aerial Vehicle Operator (AVO) interfaces and emerging AVO decision support tools, in order to evaluate inefficiencies in the current HMI display, and leverage human factors design and analysis to provide best practices on system interface layouts to maximize performance and minimize operator workload.

200126-N-AC117-0150 AIR FORCE BASE, Guam (Jan. 26, 2020) - An MQ-4C Triton unmanned aircraft system lands at Andersen Air Force Base. (U.S. Navy photo by Mass Communication Specialist 3rd Class MacAdam Kane Weissman

PROJECT DURATION

OCT 2021 - OCT 2023

SPONSOR

NISE

POINTS OF CONTACT

Beth Atkinson (PI)
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DESCRIPTION/NEED

Due to findings associated with the MQ-4C Triton platform, multiple human factors and workload issues are suspected causal factors for operator performance challenges. This effort will provide insight into current AVO interface functionality, including data entry, display, control, error reporting, and operator workload to inform best practices to training. This will include an analysis of optimal HMI display configurations and job aid capabilities. Through this design and evaluation effort, this effort seeks to alleviate workload and enhance usability in support of enhanced AVO training outcomes and operational performance delineated in the MQ-4C PBSS (Performance Based System Specification) and MIL-STD-1472F (DEPARTMENT OF DEFENSE DESIGN CRITERIA STANDARD: HUMAN ENGINEERING).

BENEFITS

This research serves to inform concept of operations and human machine interface (HMI) design will offer quantitative analysis of the capabilities and effectiveness of the technology, supporting justification and planning for accelerated acquisition to deliver this emerging technology to the fleet. Further, this effort will inform immediate layout and implementation best practices for the AVO interface for Triton training. Lessons learned will be of benefit to future manned-unmanned teaming platforms that leverage data synthesis and automation capabilities.

STATUS

This is a new start in FY22.

MILESTONES

- Year 1: Human Factors heuristic evaluation of Triton AVO HMI layouts; IRB package and approval for iterative usability and workload testing; Data regarding current AVO workload during training events; Initial usability report
- Year 2: Report on iterative usability testing, including AVO interface with and without OPTIMUS PRIME add-on; Report on workload testing, including AVO HMI with and without OPTIMUS PRIME add-on; Mockups for improvements in current AVO HMI; Mockups for optimized AVO HMI and integration of OPTIMUS PRIME

AVIATION RECONFIGURABLE COCKPIT FOR HYPOXIA & HAZARD EXPOSURE & RECOGNITION (ARCH2ER) AF090-027

OBJECTIVE

For research, development, and testing of reconfigurable and modular cockpits and controls for aviation pilot training that are low-cost but moderate fidelity to support immersive training devices.

Research and development to investigate means to deliver moderate to high fidelity training that benefits various platform capabilities, resulting in a testbed that delivers high fidelity controls for a flight simulation with integrated instructional capabilities.

PROJECT DURATION

OCT 2018 - JAN 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)
Naval Undergraduate Flight Training Systems, PMA-273
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD-SG

POINTS OF CONTACT

Beth Atkinson (PI)
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DESCRIPTION

This effort seeks to evaluate the feasibility of a reconfigurable training system to provide higher-fidelity emergency procedure training in aviation survival training centers, Fleet synthetic or Live Virtual Constructive (LVC) training centers (configure to needed platforms for next training exercise), and deployed training sites with limited space and multiple T/M/S in the area.

NEED

As the Navy seeks to identify ways to provide low-cost, high fidelity training options with a family of training systems, novel solutions such as augmented reality are under investigation.

BENEFITS

Development of a reconfigurable cockpit training solution provides an opportunity to increase training fidelity at locations where aircrew from multiple platforms are trained while minimizing costs and footprint requirements when compared to platform-specific training solutions. Additionally, by advancing the fidelity of hardware cockpits and controls while seeking to minimize costs, this effort provides initial research into solutions that may increase the feasibility of augmented reality training.

STATUS

A Phase III contract was awarded to focus on the design and development of an initial reconfigurable cockpit, development of an intuitive instructor operator station, and the test and demonstration of resulting prototypes (SEP 2018). Early developmental prototype demonstrated (DEC 2018) with prototype systems delivered to Aviation Survival Training Centers in Pensacola, FL (JUN 2019) and Miramar, CA (JUL 2020) for evaluation and testing. Continued development continued in FY20 and FY21, to include integration of research capabilities (e.g., eye tracking, speech analysis).

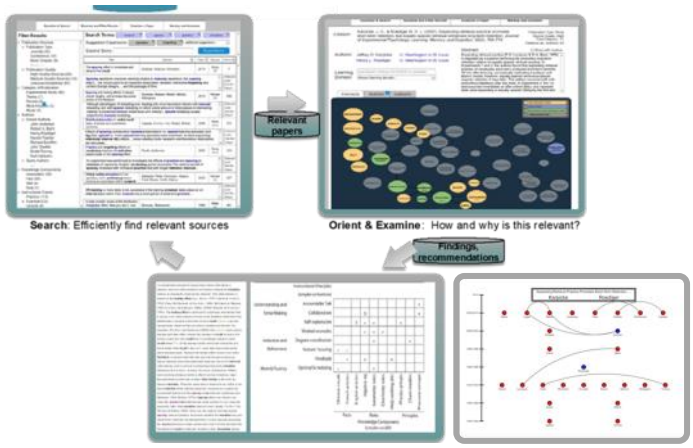
MILESTONES

- Workforce Development: Mentored junior teammates on program management and contract package development
- Presentations: Demonstration exhibit at IITSEC (DEC 2018); presentation focused on advanced training capability at the annual SAFE Symposium (OCT 2019)
- Transitions:
  - Three prototypes have been delivered to the Pensacola, FL, Aviation Survival Training Center (ASTC) in 2019, which includes hardware for F-18, T-6 and F-35 configurations, with software support for F-18, T-45, T-38, F-35, and T-6
  - One prototype has been delivered to the Miramar, CA, ASTC in 2020 with hardware for F-18 and F-35 and software support for additional platforms
  - Two research units were developed and delivered in SEP 2020. Units delivered support hardware for F-18, F-35, T-6, and F-16 with software variations for additional platforms including T-45 and T-38. To support research initiatives, the systems support integrated eye tracking and speech analysis capabilities to support future research and development of advanced after action review capabilities
  - The development team continues to explore alternative configurations to decrease procurement cost, increase system capabilities based on end user feedback, and explore transition path via PMA-205 General Training
- The development team continues to explore alternative configurations to decrease procurement cost, increase system capabilities based on end user feedback, and explore transition path via PMA-205 General Training, identifying a range of technology solutions that can meet a variety of budget limitations

COMPLEX-KNOWLEDGE VISUALIZATION TOOL (N17A-T004)

OBJECTIVE

The objective of this project is to develop a tool that synthesizes learning and cognitive science literature and provides compelling, data-based information and visualizations to support training system acquisition decisions. For example, the tool would support analysts trying to answer questions such as: "What is the return on investment if a debriefing system is included with the training system?" and "What training system fidelity is needed to facilitate learning and transfer?"



Search results and visualizations facilitating synthesis and understanding of complex learning science literature.

PROJECT DURATION

SEP 2018 – SEP 2020

SPONSORS

Naval Aviation Training Systems Program Office, PMA-205
Naval Air Systems Command (NAVAIR) Small Business Innovative Tech Transition Research (STTR)

POINTS OF CONTACT

Dr. Dawn Riddle, Ph.D. (PI)
LT Michael Natali, Ph.D.
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DESCRIPTION

This Phase 2 STTR effort will result in a cloud-based tool leveraging a learning science ontology to support intelligent literature search, analysis, synthesis, and reporting of complex information. The tool provides users with:

- guided query formation and expansion supported by learning sciences ontology-based visualizations.
- literature results review through intelligent paper markup and annotation.
- synthesis, characterization, and visualization of data and relationships across multiple papers.
- Acquisition-oriented decision support visualizations.

NEED

The work performed for this effort supports the Advanced Instructional Techniques Technology Area.

BENEFITS

The tool will improve training system quality by assisting users in extracting, synthesizing, and providing learning and cognitive science based evidence for acquisition related recommendations.

Users (analysts and decision makers) will gain a more comprehensive understanding of issues related to a query; not only theoretical and empirical evidence synthesized to support an "answer" to the query, but also an understanding of, e.g., gaps in the research, who is performing related research and within which organizations, what trends are exhibited in research over time. Information of this type is especially relevant when dealing with cutting-edge technologies.

STATUS

Two performers were selected to complete option tasks and continue to Phase 2. Performers are in Year 1 of Phase 2.

MILESTONES

- Functional product demonstration (Minimal Viable Product; MVP) October 2019
- iCloud based user testing, 1st quarter FY20
- Tool delivery end of FY20

OPERATIONAL PARTNER TO INTERACTIVELY MANAGE UNINHABITED SYSTEM PROCEDURES & RESPONSES IN MULTI-EMERGENCIES (OPTIMUS PRIME; N07-T031)

OBJECTIVE

Develop a software technology that leverages machine-learning to assist operators by prioritizing and reasoning over malfunction errors and troubleshooting.

Conceptualization of Concept of Operation and User Interface

PROJECT DURATION
DEC 2019 - DEC 2022

SPONSOR
Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

POINTS OF CONTACT
Beth Atkinson (TPOC)
Dr. Emily Anania, Ph.D. (Co-TPOC)
John Hodak (PM)
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DESCRIPTION
As the complexity of Tactics, Techniques, and Procedures (TTP) increase, testing in part via computational simulation and optimization is necessary. Such analyses systematically vary tactical applications of the warfare capability to a variety of threat scenarios, simulate and score each encounter, and generate a ranked list of the most successful tactics per threat, resulting in a wealth of data. OPTIMUS PRIME machine-learns from NATOPS data and procedures and human, expert Air Vehicle Operators (AVO) how they generate, select, and execute malfunction Emergency Procedures to provide corrective actions, and assists operators by assessing malfunction errors to support fault resolution.

NEED
The possibility exists for over 20 cascading fault codes in less than five seconds. In order to prevent aviation disaster, there is a need for technology that (1) machine-learns from human unmanned aerial vehicle (UAV) operators how they generate, select, and execute malfunction Emergency Procedures (EP) to provide corrective actions, and (2) assists operators by prioritizing and reasoning over malfunction errors and troubleshooting steps to increase the probability of successful fault diagnosis and fault resolution in flight.

BENEFITS
The inclusion of a machine-learning system that assists with fault resolution will significantly diminish the risk of platform loss, by better training operators to understand and react to fault codes. Such a system can also be instrumental in operational flights. AVOs will manage emergency procedures more effectively and efficiently, due to both training and in-flight support.

STATUS
In early FY20, a kickoff meeting was held with stakeholders to discuss the design and development plans for the OPTIMUS PRIME technology. Documentation has provided a baseline knowledge base, as well as subject matter expertise, for the design of the system architecture and automation. Focus is on fault detection and likely root cause analysis based on cascading malfunction codes. Demonstration event in OCT 2021 resulted in strong support from the program office that will result in additional fleet input and potential integration opportunities through the end of the current Phase II effort.

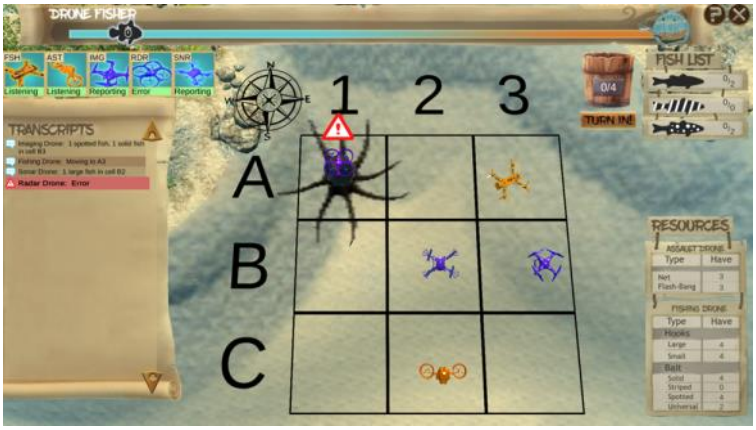
MILESTONES

- Kickoff meeting for Phase II effort held in Patuxent River, MD (FEB 2020) with stakeholders from NAWCTSD and PMA-262
- Development team has coordinated a system concept and developed derived requirements based on available documentation and subject matter experts, and developed a framework and infrastructure for technology development
- Development of learning models anchored in data structure and meaning, as well as human expertise and behaviors, including integration of machine learning models and logic programming
- Baseline user interface is developed based on operational interface concepts
- Demonstration event with PMA-262 stakeholders of prototype capability

UNDERSTANDING THE EFFECTS OF AUTOMATION TRANSPARENCY (BAR-21-023)

OBJECTIVE

Investigate training and design strategies for complex human-autonomy interaction and their relationships to situational awareness, operator cognitive workload, and trust factors associated with and operation of highly automated and autonomous systems.



DroneFisher Game to Support Levels of Transparency Research

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR

POINTS OF CONTACT
Dr. James Pharmer, Ph.D. (PI)
Beth Atkinson (Co-PI)
Dr. Emily Anania, Ph.D. (Co-PI)
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DESCRIPTION
Development of an integrated design (automation transparency) and training solution incorporating workload, trust, and situation awareness will result in improved performance on human-autonomy interaction tasks. The results of this effort will provide integrated training development and system design guidance and standards for the most effective ways to introduce complex/autonomous systems to the Fleet for best human system performance.

NEED
As automation becomes more prevalent in training and operational systems, there is an increased need to understand how best to design human-automation interfaces. Though the potential benefits of automation are well-understood, much is still unknown regarding the safe and appropriate use and design of automation to facilitate human -automation teaming. As automated and autonomous systems become "teammates," there is a greater need to understand how design and development of these systems will influence human performance, as well as the performance of the overall team, including manned and autonomous components.

BENEFITS
This aim of this project is to better understand the effects of different automation design characteristics on important human outcomes (e.g., workload, performance, situational awareness, trust). Though individual systems and interfaces will likely have different needs, the results of this study can provide general lessons learned for the future design of systems and interfaces for optimal human-automation interaction.

STATUS
Completed literature reviews for general topic and design element-specific topics; Conducted SME interviews of individuals in multiple communities; Began analyses of SME interviews; Drafted FY22 research protocol. Products Developed: Initial recommendations for research testbed, including design examples (to be tested and improved during FY22); Recommendations for training regarding automation transparency (to be expanded during FY22)

MILESTONES

- **FY21:**
  - ◊ Report on the assessment of possible effects of design (automation transparency) and training factors (competencies, training methodologies, metrics) on SA, Workload, and Trust
  - ◊ Qualitative Task Analysis Report utilizing background research and literature and interviews with subject matter experts
  - ◊ Documented human performance data collection plan.
- **FY22:**
  - ◊ Report/conference submission on the results of human in the loop experimentation based on knowledge gaps identified
  - ◊ Documented design recommendations to include mockups and examples; Improved game-based training tool and testbed for autonomy interface design (DroneFisher)

VARIABLE ACCOMMODATION HEAD-MOUNTED DISPLAY (HMD) (N121-041)

OBJECTIVE

To overcome the vergence-accommodation conflict and fatigue in head-worn displays.

Screenshot of the proposed virtual test environment.

PROJECT DURATION

DEC 2017 - DEC 2021

SPONSOR

Naval Air Systems Command (NAVAIR) Small Business Innovation Research (SBIR) Phase II.5

POINTS OF CONTACT

Benito Graniela (TPOC)
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DESCRIPTION

The proposed technology incorporates variable accommodation into the HMD to eliminate the conflicting cues and decrease fusion time of binocular imagery and accuracy. The project will leverage the Variable Collimation Display (VCD) technology developed under the current NAVAIR SBIR topic N121-041 Phase II program. Specifically, the VCD's Variable Adaptive Lens (VAL) technology, control electronics and software will be adapted to fit in head worn display similar in size, shape and field -of-view to current commercial HMDs. The VAL will be integrated in a head worn display (i.e. VAHMD) in order to stimulate accommodation-vergence response in the user, thus improving an enhanced immersive experience.

NEED

Accommodation depth cues (i.e., focus) are currently not replicated in current head worn displays. Instead, the eye is forced to focus on a fixed image plane regardless of the object location, resulting in a vergence-accommodation conflict. This limitation hinders the user's ability to accurately judge distances, reduces the user's sense of immersion and can cause or exacerbate virtual reality sickness (eye strain, dizziness, etc.).

BENEFITS

The anticipated benefits and potential commercial applications of the VAL when incorporated into high-resolution and wide-field-of-view head worn displays include: (i) improvement in users' immersion; (ii) reduction in Virtual Reality (VR) sickness (eye strain, dizziness, etc.); and (iii) improve spatial awareness and more accurate judgement of depth and image distance.

STATUS

The two-year program was partitioned into four 6-month phases, or "Spirals". Design Interactive (DI) evaluated the VAHMD and found that VAHMD can perform well at multiple depth planes while conventional HMDs degrade in performance when objects are placed outside their fixed depth plane. Holochip has had healthy commercial sales of VAL Development Kits to leading tech companies and HMD developers for evaluation of the technology. VAHMD program was severely impacted by the coronavirus. Final VAHMD headset to NAWCTSD planned for delivery and evaluation prior to contract end, 12/31/21.

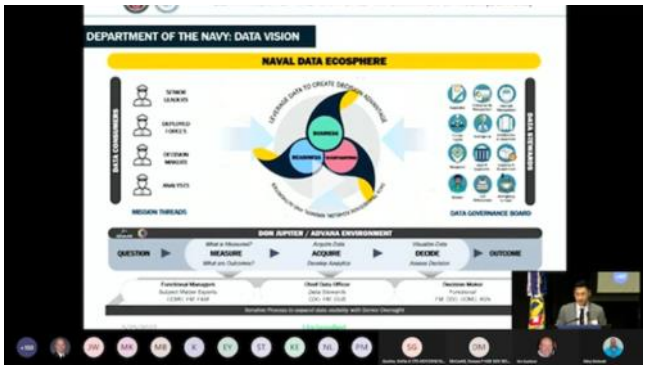
MILESTONES

- Manuscripts/Publications: Batchko, R., Robinson, S., Schmidt, J., & Graniela, B. (2014, March). A variable-collimation display system. In Proc. SPIE (Vol. 9011, p. 901109).
- Presentations:
  - Spiral 2 (Month 6) Design Review 8/21/18
  - Spiral 1 HMD delivered and presented at NAWCTSD, April 10, 2018
  - Spiral 2 HMD delivered and presented at NAWCTSD, March 7, 2019
  - Spiral 3 HMD delivered and presented at NAWCTSD, December 2021

PREDICTIVE DATA ANALYTICS TO REFINE AIRCREW TRAINING AND OPERATIONS (N21B-T024)

OBJECTIVE

Research and develop a technology that supports ingesting large and disparate data sets from naval aviation aircraft and uses data science to provide outputs that increase enterprise level knowledge of aviator performance, safety, and effectiveness through data-driven predictive analytics to influence training and operations.



Increased use and visibility of emerging technologies to support predictive data analytics offer unique opportunities in the future. For example, in May 2021 during Department of the Navy Chief Information Officer panel discussions, leadership addressed the DON Data Vision as part of the discussion on The Means for Modern Maritime.

PROJECT DURATION
SEP 2021 - SEP 2022

SPONSOR
Naval Air Systems Command (NAVAIR) STTR

POINTS OF CONTACT
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DESCRIPTION
The Navy requires a technology that supports ingesting large and disparate data sets from naval aviation aircraft, supporting required parsing, sorting, and fusion to manage relevant data. Development efforts should focus on providing data analytic functionality that results in outputs that increase enterprise-level knowledge of aviator performance, safety, and effectiveness. Further, the technology functionality should extend traditional data science solutions to include capabilities for data-driven predictive analytics to influence training and operations. The research and development effort should provide focus on the visualization capabilities to increase end user understanding of data analysis processes and outputs, in addition to an underlying data analytic architecture.

NEED
The success of military operations significantly depends on the level of quality training, safety, and operational effectiveness demonstrated by its personnel. This is especially true for naval aviation operations. There are a large set of factors that affect the successful employment of naval aircraft during peacetime and wartime. These factors can change with time and with the situation and are articulated in vast and disparate data sets. These data sets, when captured, traditionally provide immediate evaluation and aircrew debrief. Generally, a vast amount of data that affects and describes crew performance is discarded or stored with no long-term data analytics processing conducted that could provide valuable trend and predictive insight.

BENEFITS
This effort focuses on providing data analytic functionality that supports ingesting large and disparate operational and training data to manage relevant data to include capabilities for data driven predictive analytics to influence training and operations. With the emergence of advanced computing analytic techniques, existing and new methods need to be applied to operations and training performance data sets to increase enterprise-level knowledge of aviator performance, safety, and effectiveness. Understanding of these trends provide decision makers at multiple levels of leadership with an ability to target improved training approaches and operational system improvements. This high-impact/ payoff technology would improve warfighter/aviator human performance and safety due to improved training using predictive data analytics on large disparate data sets.

STATUS
Topic was released as part of the 21.2/21.B topic call. Competitive source selection from initial proposals resulted in 3 Phase I awards. Vendors are exploring capability needs and refining system design concepts in preparation of submitting a Phase I feasibility report.

MILESTONES

- Phase I: Develop, design, and demonstrate a strategy, taking into consideration the feasibility, suitability, and acceptability, to leverage all available aircraft and related crew performance data. Identify potential roadblocks likely to be encountered and formulate approaches to overcome them. Design an architecture and implementation plan illustrating the benefits of training analytics through training use cases to demonstrate benefits of predictive analytics. The Phase I effort will include prototype plans to be developed under Phase II, with consideration for options on system architecture (e.g., Navy Marine Corps Intranet, standalone system).
- Phase II: Develop a working prototype of the selected concept to include high-level requirements, design, initial testing, and demonstration. Demonstrate the prototype in a lab or live environment. Planning and consideration for information assurance compliance and certification for an authority to operate, including updates to support installation on Navy Marine Corps Intranet (NMCI) systems or other Department of Defense hardware.

VIRTUAL REALITY (VR) FOR TRAINING: EXAMINING THE BENEFITS OF HAPTIC FEEDBACK AND NATURAL GESTURES ON LEARNING (BAR-19-022)

OBJECTIVE

To evaluate virtual reality (VR) technology by systematically examining the effects of supporting natural interactions (e.g., locomotion, gestures) and haptic feedback on learning outcomes and other factors such as feelings of presence, usability, and cognitive load while training in VR.

Example student completing a training exercise in VR.

PROJECT DURATION

OCT 2019 - SEP 2022

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR

POINTS OF CONTACT

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DESCRIPTION

There has been a recent flurry of interest by Fleet customers and stakeholders to provide virtual reality (VR)-based training across a variety of platforms and tasks. VR offers the potential to train tasks that may not be feasible to practice in the real world, but care must be taken to consider when and how to incorporate VR technologies within the training pipeline to ensure it is the right solution to achieve training goals. Therefore, the goal of this effort is to conduct research to explore different tasks and different methods of interaction between the trainee and the environment in a VR-based training environment to determine how these variables affect learning and other factors such as feelings of presence, usability, and cognitive load. Specifically, we aim to explore the impacts of more high-fidelity interactions within the environment, such as natural gestures and haptic feedback across different task types.

NEED

VR training solutions have the potential to reduce training cost, increase training impact, and maximize transfer of knowledge from the classroom to the operational environment. Knowing the capabilities and limitations of the technology and when to apply it as a training solution will allow the Navy to build more effective and efficient training. Furthermore, this research will enable the NAE to remain at the front of applied S&T understanding on how best to make use of these technologies to support Fleet readiness.

BENEFITS

This research is critical to provide timely evidence-based recommendations to Fleet customers on the benefits and risks of using VR for training and will culminate in a research testbed with integrated haptic gloves, several published conference proceedings papers, and journal articles to address significant gaps in the science of learning literature.

STATUS

In FY20, the research team developed a research testbed and designed Experiment 1, which focuses on exploring the impacts of natural interactions in VR on learning outcomes in a spatial task. In this task, trainees learn to find critical safety equipment onboard a virtual submarine under different training conditions. In FY21, researchers conducted Experiment 1 and designed Experiment 2, in which the goal is to examine the impact of performing natural gestures in a procedural VR-training task. In FY22, the team will complete Experiment 2, conduct data analysis, and write up results for publication for both experiments.

MILESTONES

FY20:

- Designed Experiment 1 and received IRB approval. Received endorsement to conduct experiment at Submarine Learning Center (experiment postponed due to COVID-19).

FY21:

- Completed research testbed development, incorporating natural interactions to explore their effects on learners' spatial understanding of the virtual environment. Conducted Experiment 1.
- Designed testbed to support Experiment 2, incorporating haptic feedback and natural gestures for a procedural task. Designed Experiment 2 and received IRB approval.

FY22:

- Complete Experiment 2 testbed. Conduct Experiment 2.
- For both experiments, conduct data analysis and write up results for publication.

AN INVESTIGATION OF EYE MOVEMENT INDICATORS FOR PHYSIOLOGICAL EVENTS (PE) (ILIR-20-007)

OBJECTIVE

Demonstrate the ability of eye tracking technology to identify physiological events (PEs) in-flight or in training. In addition, this project will result in an early prototype debriefing software capability for use in PE training environments that provides video replay with eye tracking analysis overlays so trainees fully understand the gravity of PEs in operational situations.

Normobaric Hypoxia Trainer Pilot Training Station with Notional Eye Tracking Range

PROJECT DURATION
OCT 2019 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division (NAWCAD) In-House Laboratory Independent Research (ILIR)

POINTS OF CONTACT
Dr. Mitchell Tindall, Ph.D. (PI)
Beth Atkinson (Co-PI)
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DESCRIPTION
The research seeks to investigate whether abnormal deviations of eye movement and oculometric from baseline will correlate significantly with trainees' subjective reports of hypoxia symptomology. Additionally, this research will also attempt to determine whether deviations of eye movement from baseline will correlate significantly with other physiological indications of a PEs. Eye-tracking technology offers a potential method to detect and monitor significant changes in vision and eye movement associated with hypoxia experienced by naval aviators. Research will be conducted in mask-on and/or maskoff normobaric hypoxia training and research environments, and data collection will include demographics, eye-tracking, physiological data, and subjective data.

NEED
Hypoxia presents an immediate life-threatening situation for any pilot. Hypoxia, or lack of oxygen, impairs psychomotor capabilities and deteriorates an aviator's mental and physical health. This situation leads to grounding of crew, which stalls naval operations, but can also lead to more grave outcomes such as death. Therefore, finding ways to preemptively detect symptoms of hypoxia and advance associated safety training is of the upmost importance for fleet readiness.

BENEFITS
This research will determine the potential for modern eye-tracking hardware and software to preemptively identify the onset of a PE for hypoxia, and potentially minimize the possibility of type 1 and type 2 errors when alerting Navy aviators for this condition. Additionally, this effort will also result in an enhanced debriefing capability that will show trainees specifically how they are impacted by hypoxia even when they are not consciously aware.

STATUS
IRB protocol submitted OCT FY22. Authorization for conducting the study at the ASTCs was acquired from the leadership at the Naval Survival Training Institute SEPT FY21. Initial pilot testing is planned for in Q2FY22 with the internal research team. Live data collection is planned to take place in Q2 FY22.

MILESTONES

- **FY21:**
  - Acquisition and assembly of data collection infrastructure
  - Completion of testbed and backend research design
  - Formal approval for data collection at the Aviation Survival Training Centers from the Naval Survival Training Institute
- **FY22 Planned:**
  - Pilot data collection Q1
  - Live data collection Q1-Q3
  - Analysis and reporting Q4

DART: DATA-DRIVEN AFTER-ACTION REVIEW TOOL FOR STUDENT PILOT PERFORMANCE ASSESSMENT USING FLIGHT DATA (TT-20-001)

OBJECTIVE

Develop a data-driven after-action review tool for T-45 instructor pilots with capabilities to visualize flight trajectories, identify maneuvers, and automatically and objectively evaluate pilot performance.

Two T-45C training jets prepare to perform flyover maneuvers. (U.S. Navy photo by 1st Lt. Andrew Straessle, via Navy.mil Images)

PROJECT DURATION

OCT 2019 - SEP 2021

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: Tech. Transition

POINTS OF CONTACT

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DESCRIPTION

The Data-Driven After-Action Review Tool (DART) is an interactive web-based application for use in After Action Reviews of training flights on the T-45 platform. Our goal is to enhance communication between the instructor and student, while providing quantitative measures of human performance to aid instructors in standardizing their evaluations. The solution combines interactive 3D and 2D visualization of flight data, automatic maneuver identification, and performance evaluation in a web application interface.

NEED

After-Action Review for T-45 instruction currently consists primarily of verbal communication between instructor pilots and student pilots. Student miscomprehension of error and resistance to correction have been reported by instructor pilots for CNATRA, and multiple re-flys of training flights are costly. Improvement in student comprehension leads naturally to improvement in student performance.

BENEFITS

With interactive visualization, instructors will be able to convey feedback more accurately to students. The quantitative assessment of maneuver performance made by DART will produce a numerical indicator of performance for each maneuver. This numerical indicator will aid instructors in standardizing their evaluation of student pilots. Additionally, a government-owned software solution provides flexibility and agility for future support and expansion to new platforms.

STATUS

A prototype DART app has been developed and hosted. The app interface will continue to be improved with new visualization capabilities and a more user-friendly experience. Identification and evaluation of additional maneuver classes are in work.

MILESTONES

- JAN 2021: Deliver prototype DART software to instructor pilots for evaluation period
- JUL 2021: Incorporate advanced segmentation component and human performance evaluation component
- SEP 2021: Deliver final software package based on feedback from evaluation periods

DATA-SCIENCE DRIVEN AIRCREW PERFORMANCE MEASUREMENT AND PROFICIENCY SYSTEM (N181-026)

OBJECTIVE

Develop a software technology to pre-process, fuse, and store data from multiple sources for human performance assessment and proficiency tracking during training, with the capability to parse and synchronize disparate data from live, virtual, and constructive aviation training system sources to output automated performance metrics.

150903-N-SS390-266 FALLON, Nev. (Sept. 3, 2015) F-35C Lightning IIs, attached to the Grim Reapers of Strike Fighter Squadron (VFA) 101, and an F/A-18E/F Super Hornets attached to the Naval Aviation Warfighter Development Center (NAWDC) fly over Naval Air Station Fallon's (NASF) Range Training Complex. VFA 101, based out of Eglin Air Force Base, is conducting an F-35C cross-country visit to NASF. The purpose is to begin integration of F-35C with the Fallon Range Training Complex and work with NAWDC to refine tactics, techniques and procedures (TTP) of F-35C as it integrates into the carrier air wing. (U.S. Navy photo by Lt. Cmdr. Darin Russell/Released)

PROJECT DURATION

JUN 2018 - SEP 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

POINTS OF CONTACT

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Beth Atkinson (Co-TPOC)
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DESCRIPTION

This effort seeks to design and develop an architecture and process for linking available data sources to tactical aircrew performance in warfighting capabilities based on Fleet tactical recommendations and mission-essential tasks references, that is flexible to incorporate future tactics, and scalable to address individual to multi-team performance. The team will work to determine the feasibility of implementing a software-based solution to process, parse, and fuse disparate data sources and types for a single platform, as well as design advanced data science approaches intelligence for automated and human-in-the-loop data output for performance assessment, facilitating feedback, and support longitudinal trend analysis computations.

NEED

The current state-of-the-practice for performance assessment relies heavily on subjective rating, which is hampered by a manually intensive and time-consuming process. A software tool that provides an automated mechanism to pre-process and fuse multiple data sources for human performance assessment and proficiency tracking in warfighting capabilities would alleviate this burden. Specifically, to develop computational methods that can assist with timely and continuous calculation of aircrew performance, proficiency and identify associated trends.

BENEFITS

Better feedback to aircrew will improve performance by identifying training gaps. Increased quantities of data on aircrew performance will enhance future mission capabilities by informing decisions on training resource requirements. This effort seeks to close debrief and reporting gap identified by recent analyses of existing large force exercises. This gap will be present in and increasingly relevant to the effectiveness of forthcoming distributed simulation and LVC training events.

STATUS

This SBIR has undergone competitive source selection resulting in multiple Phase I awards and Phase II selections. Government stakeholders support periodic status updates and demonstrations with various potential transition sponsors to support transition planning and provide technical guidance. Multiple vendors are participating in the Navy's SBIR/STTR Transition Program (STP) in FY21-22. Iterative status updates and demonstrations have been conducted throughout Phase II efforts.

MILESTONES

- **Phase I**:
  - Kickoff meetings were held with each of the four Phase I contractors
  - Phase I status was monitored via bi-monthly progress reports, periodic status updates, and close out briefs
  - Phase I Option efforts end July 2019
- **Phase II**:
  - Phase II awards were made in July 2019 to three contractors based on Phase I effort and transition interest by PMA-281, PMA-264, PMA-290, PMA-205, and the Next Generation Threat System.
  - Periodic status updates are supported by government technical points of contact with vendors to provide transition planning and technical oversight.
  - As technologies have matured, virtual or in person demonstrations are coordinated with appropriate stakeholders for feedback.
  - Vendors and technical points of contact have participated in preparation activities for the Navy STP in FY21-22

LANDING SIGNAL OFFICER (LSO) DATA ANALYSIS TOOLKIT (LSO-DAT) (N112-111)

OBJECTIVE

Use modern technology to identify deeper trends for assessing pilots, aggregate data to identify safety issues, and make LSOs more efficient.

Landing Signal Officers (LSO)

PROJECT DURATION

DEC 2018 - AUG 2020

SPONSORS

NAVAIR Small Business Innovation Research (SBIR)
Naval Aviation Training Systems and Ranges Program Office, PMA-205

POINTS OF CONTACT

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DESCRIPTION

There are four major initiatives in LSO-DAT:

1.LSO Data Analysis Tool (LSO-DAT)–Software that interacts with APARTS data to provide in-depth reporting on individual pilots, virtual greenie boards, up-to-date CAG LSO reporting and more. Also provides LSO School and researchers tools for analyzing large numbers of pilots (e.g., squadron vs squadron comparisons).

2.Data Analytics–We have been mining APARTS data to answer questions regarding skill acquisition and skill decay in light of Precision Landing Mod (PLM) adoption and FCLP reduction.

3.Advanced Analysis of Flight Data (SIM-DAT)–We are producing flight-based visuals to incorporate with SIM-DAT (e.g., stick movement vs position in glideslope). We are also using machine learning to identify hidden commonalities in passes and their relationship to issues observed by LSOs.

4.Handwriting Recognition (LSO SCRIBE)–Neural-network-powered software that can read handwritten LSO cut sheets and automatically export them to APARTS. Minimal typing required.

NEED

The LSO community is responsible for "the safe and expeditious recovery of non-V/STOL fixed-wing aircraft" (1) landing aboard the U.S. Navy's aircraft carriers. Duties in service of this charge range from teaching and training of Student Naval Aviators (SNA) to ongoing support and management of embarked Naval Aviators. Landing fixed-wing aircraft in a limited landing area is a uniquely challenging aspect of Naval Aviation; LSOs are deeply concerned in minimizing risk for the pilots in their charge. The LSO community is facing several questions due to rapid introduction of PLM.

BENEFITS

These capabilities will enhance the LSO assessment of pilots and allow data -driven answers to questions of Pilot proficiency. Capabilities include: Provided tools for deeper level analytics and automated performance measurement in assisting in the assessment of the extent to which PLM improves the ability of pilots to acquire and retain adequate carrier landing proficiency. Provide data tools to support consideration of modifications to CQ training and currency requirements. Provide tools for automated data entry.

STATUS

This discretionary SBIR Phase II project ended in Aug 2020 and coordinated transition with the SHARP program.

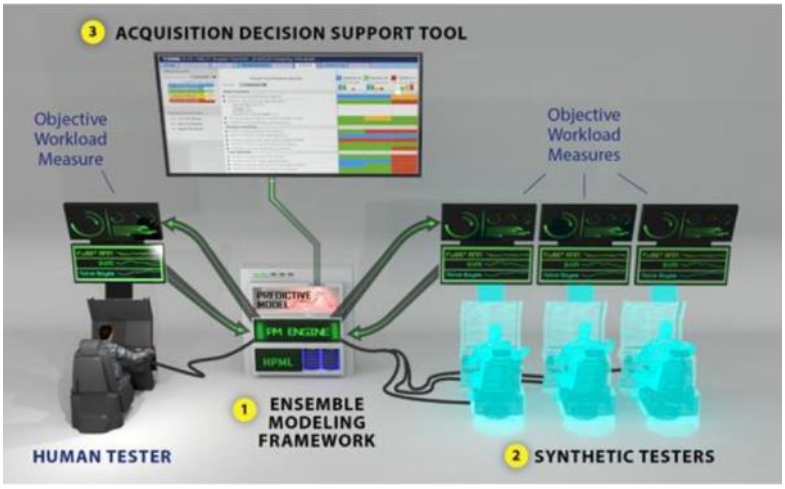
MILESTONES

- FEB 20: Presented results to LSO School and PMA 205
- JUL 20: Demonstrated capabilities to PMA-205 and SHARP Program Management
- AUG 20: Transitioned analyses and results to Sierra Hotel Aviation Readiness Program (SHARP)

MEASURES OF ABSOLUTE COGNITIVE WORKLOAD (N16A-T002)

OBJECTIVE

To develop an innovative and cost-effective capability that will provide an objective means of measuring physiological states with a focus on workload and simulator sickness for determining impacts on individual operator, crew-level, and/or multi-team system level performance.



Aptima's Tools for Objective Measurement and Evaluation applied to a notional T&E environment.

PROJECT DURATION

OCT 2014 - APR 2022

SPONSORS

Naval Air Systems Command (NAVAIR) Small Business Technology Transition (STTR) & Naval Aviation Training Systems Program Office, PMA-205

POINTS OF CONTACT

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Dr. Ada Mishler, Ph.D. (ATPOC)
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DESCRIPTION

In the Naval community, improving affordability is one of the main focus areas, and virtual reality (VR) technology has been deemed one essential component to gain increased affordability. To leverage VR systems, it is critical to understand human performance limitations when introducing complex/cognitive tasks, state-of-the-art technologies/equipment, and new environments to aviators. This effort captures physiological states within a virtual flight simulator to investigate the presence, duration, and severity of simulator sickness. Knowledge of these limitations can help inform researchers, developers, and trainers of the potentially negative impacts on safety and efficiency of operations.

NEED

Current state-of-the-practice is to assess physiological states such as workload and simulator sickness, either physical or cognitive in nature, through a variety of assessment methods. The most commonly implemented are subjective measurement techniques; however, there is an increased desire for more objective data on which to base acquisition decisions. Although some objective measurement techniques exist for physiological states, new, cost-reducing methods are needed to support system acquisition and implementation decisions.

BENEFITS

This effort seeks to investigate a hybrid approach that would allow for real-time measurement of physiological state, specifically simulator sickness, as well as physical and cognitive workload. Modeling capabilities will be used to understand how variations in the associated factors might affect aviator safety and performance. Result from this effort can help inform Chief of Naval Air Training (CNATRA)'s training policies.

STATUS

In FY21, Aptima was awarded additional funding to both mature and expand their initial prototype capabilities focusing on workload to include measurement of VR simulator sickness. During this time, protocols were developed and approve for the validation study. The team acquired materials/equipment to upgrade two flight testbeds and created flight scenarios in support of data collection.

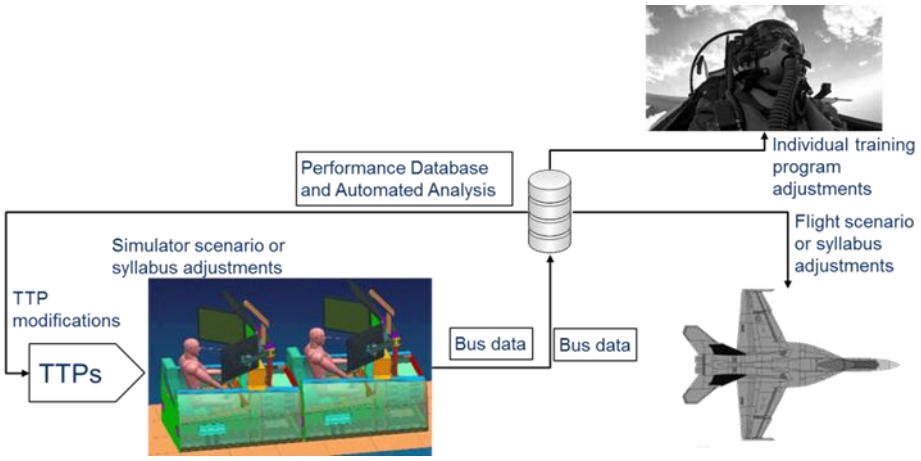
MILESTONES

- Phase I: Develop framework for a prototype; gated approach
- Phase I Option I: Develop initial prototype; options were awarded for two vendors
- Phase II: Develop additional prototype features; gated efforts awarded for two vendors
- Phase II Option I: Demonstrate prototype functionality via collected data; option awarded to one vendor
- Phase II Expansion: Conduct a validation study measuring VR simulator sickness in support of CNATRA's Naval Aviation Training Next effort. Results will be included in a report to help implement safety training protocols for VR devices.

ONR FUTURE NAVAL CAPABILITY FLEET ADAPTIVE MULTILEVEL MEASUREMENT FOR OPERATIONS AND UNIT SYSTEMS (FAM2OUS)

OBJECTIVE

Provide integrated collection, fusion, analysis, archive capability for LVC training and operational events across platforms to increase proficiency, readiness, and overall mission performance through improved accuracy of assessment and quality of instruction.



Data Framework Developed by NAWDC

PROJECT DURATION
OCT 2019 - SEP 2022

SPONSOR
Office of Naval Research (ONR); Naval Aviation Training Systems Program Office (Program Management Activity [PMA] 205)

POINTS OF CONTACT

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DESCRIPTION
The science and technology of this Future Naval Capability (FNC) focuses on developing assessment capabilities that automatically and adaptively collect, fuse, display, analyze, and archive training data (Live, Virtual, Constructive) from disparate systems. Competency-based, automated objective performance measures will be developed at the individual, unit, and carrier strike group level. These measures will be used for debrief and trend analysis to support decision making (currency, proficiency, acquisitions). Additionally, these measures will enable comparison between live, virtual, and constructive (compare differential impact of simulation and live training opportunities). These data will be stored in a centralized system that will enable rapid development of post-mission and readiness reports.

NEED
Performance assessment of Carrier Airwings (CVWs) during integrated training relies solely on qualitative instructor assessments presenting resource challenges with manpower, training time for instructors, standardization of metrics and feedback, and overall accuracy of recorded data. This practice requires instructors to pull data from multiple, disparate, often stove-piped systems and manually synthesize these data to conduct debrief and provide assessments which is time intensive.

BENEFITS
This capability will provide instructors with relevant data that is automatically fused to allow for increase in reduction in manpower and time requirements for instructors. This will also reduce instructor workload focused on assessment and allow for increased quality of instruction and ultimately greater warfighter proficiency and readiness. Finally, this tool will allow for comparison between simulator and flight performance, assess the effect of simulator rehearsal on live flight proficiency, and enable development Concept of Operations and refinement of Tactics, Techniques, and Procedures (TTPs).

STATUS
During year two of this FNC, development focused on integrating the real-time event recognition capability with the Next Generation Threat System's Analysis and Reporting Tool (debrief) to enable a cohesive measurement toolset. Additionally, requirements have been developed to support implementation of a Big Data Storage System. Finally, development of ingestors for SHARP data and algorithms to support data queries have been implemented to allow for analysis.

MILESTONES

- Collected preliminary Event Recognition data inputs from NAWDC
- STRIKE, Carrier Airborne Early Warning Weapons School, TOPGUN, Aegis
- Conducted virtual user profile data collections
- Conducted nine demonstrations to various communities including: end users, potential transitions, and resource PMAs
- Identified the Naval Aviation Distributed Training Center as secondary transition
- Conducted NAWDC User Feedback event on all FAM2OUS tools
- Conducted two classified integration events

TECHNIQUES TO ADJUST COMPUTATIONAL TRENDS INVOLVING CHANGING DATA (TACTIC-D) (N17B-T032)

OBJECTIVE

Develop technology based on statistical or computational methods to assist in the continued tracking of training performance and proficiency trends as underlying tactical data changes.

Racks containing Naval Integrated Tactical-Cloud Reference for Operational Superiority (NITROS) capabilities.

PROJECT DURATION

MAR 2019 - MAY 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Technology Transition (STTR)

POINTS OF CONTACT

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DESCRIPTION

The continued push for integrated warfare will likely result in cross platform, mission-based trends; however, there may be differences in constructs across platforms (e.g., one platform may rely on timeliness and another on accuracy) that if not accounted for in the analysis or development of common construct definitions would skew analysis results. This effort seeks to identify statistical or computational methods that can assist with these adjustments to statistical trends, and implement them in an automated tool that will allow for the timely and continued calculation of trends related to fleet performance and proficiency.

NEED

The DoD and USN seek to leverage the benefits of qualitative data analytics for tactical proficiency assessment to support decision making. Military domains for big data is unique in that the tactics, techniques and procedures used by the fleet shift over time due to changes in capabilities or the need to adapt, creating a unique challenge for the typical statistical processing to ensure that comparisons remain meaningful.

BENEFITS

Navy leadership has called for technologies that support analytics of big data sets such as avionics and human performance; however, as new systems or technologies are introduced and/or new tactics emerge to maintain superiority, underlying data sources may change. At this time, systems are built to support basic trends and statistical outputs, without accounting for this shift. Given the implications of decision makers relying on outputs to adapt training, modify resources or refine tactical approaches, a solution for understanding the implications or adjusting results based on these types of shifts is required. Advance statistical or novel modeling techniques are sought to address this unique challenge.

STATUS

Three vendors completed Phase I efforts, resulting in a down select to a single vendor in Phase II. The Phase II base period is complete and the option period has been awarded. Discussions and demonstrations with stakeholders are scheduled for the option period to strategize transition.

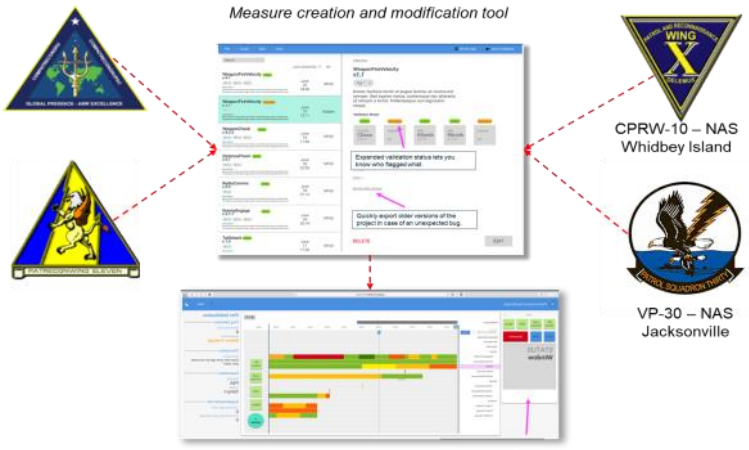
MILESTONES

- Manuscripts/Publications: Fegley, Carlin, Cheng, Tindall, Killilea, & Atkinson. (2019). Avoiding Data Overload in an Adaptive Training Use Case. Modsim.
- Phase I:
  - Kickoff meetings were held with each of the three Phase I contractors
  - Contractors status was monitored via bi-monthly progress reports and periodic status updates
  - Closeout briefs were held with each of the contractors to discuss Phase I progress and Phase II plans
  - Phase I Option was awarded for single vendor
- Phase II:
  - Progress brief in JUN 2020 to determine the path/focus for the remaining period of performance
  - Development has focused on effects analysis, anomaly detection, and advanced visualizations for integration in the software prototype
  - The project has been registered with the Navy's SBIR/STTR Transition Program (STP)
  - Phase II option has been awarded

TRANSITION OF END-USER AUTOMATED PERFORMANCE MEASUREMENT TOOL (TT-19-018)

OBJECTIVE

Provide Fleet customers with an in-house capability for developing, modifying and implementing automated and observer-based performance measures within a broader performance measurement system.



Measure creation and modification tool.

PROJECT DURATION

APR 2019 - DEC 2021

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: TT

POINTS OF CONTACT

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DESCRIPTION

Current solutions for developing and integrating automated performance measures into training systems require a lengthy contractual process to hard code modifications to existing measures or add new measures. An opportunity exists to empower the warfighter, in conjunction with leadership, to rapidly respond to changes in the environment by modifying existing measures or creating new ones to ensure TTPs and performance standards are current. This effort seeks to place the power of software system modification and development in the hands of the end-user.

NEED

In military contexts, where change is inevitable and rapid, it is crucial to ensure we are training to stay ahead of our adversaries, constantly challenge the status quo, and saving costs. The current effort seeks to address this fact, creating software which will allow end-users (e.g., Commanding Organizations, Wing and Squadron Instructors, Deployed Units) to easily create and implement automated and observer-based performance measures into training immediately, without the need for alternative contracts each time new performance measures are needed.

BENEFITS

Navy leadership has called for technologies that support analytics of big data sets such as avionic or human performance. This efforts seeks to provide a way for end-users to develop, modify, and implement automated and observer-based performance measures within a broader performance measurement system.

STATUS

Complete.

MILESTONES

- Award Q2 FY19
- Data collection and analysis completed FY21
- Effort resulted in 3 software builds for Workbench
- Publications/Presentations:
  - ◊ Rickel, Tindall, Atkinson, & Entinger (2020). A Heuristic-based approach to prototyping Workbench. Simulation and Interoperability Standards Organization.

AFTER ACTION AND REPORTING TOOL FOR DISTRIBUTED LIVE, VIRTUAL, CONSTRUCTIVE (LVC) TRAINING (TT-21-009)

OBJECTIVE:

Conduct research to understand distributed LVC after action and reporting requirements, how those compare to single site VC requirements, and develop a method for presenting data in a more standardized fashion. Specifically, this effort aims to create a uniform interface to allow for seamless utilization across multiple media and of training (L, V, C) and delivery method (single site, distributed) by conducting an analysis of requirements and gaps across user communities and provide optimal debriefing.

Screenshot from NGTS ART

PROJECT DURATION

OCT 2020 - SEPT 2021

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: Tech Transition

POINTS OF CONTACT

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CDR Thomas Foster (PM)
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DESCRIPTION

This effort will leverage the data source investigation conducted under the Office of Naval Research funding Fleet Adaptive Multilevel Measurement for Operation and Unit Systems (FAM2OUS) program to support identification and implementation of requirements that go beyond single site Virtual/Constructive (VC) training to support distributed Live/Virtual/ Constructive (LVC) events. These capabilities will allow Next Generation Threat System Analysis and Reporting Tool (NGTS ART) to better meet the needs for both the Naval Air Warfare Development Center and the Naval Aviation Distributed Training Center (NADTC) by providing a standardized and more comprehensive picture of human performance across the training pipeline. While the initial use case is planned for NGTS ART as it aligns to the NAWDC and NATDC requirements, the analysis of requirements will focus on overall debrief and a cross walk can be done for NGTS ART and any other system of interest.

NEED

Multiple communities throughout the NAE utilize NGTS including F/A-18, F-35, NADTC. However, requirements are pushed to Final Operational Capability development with the mindset often being "we'll use what's there." This presents a challenge as the ART requirements have been heavily driven by Fighter, single site communities. As we move to integrated, distributed, multi media (LVC) events, NGTS ART will fall short to provide learning points required to foster integration assets. This effort is necessary to identify the shortfalls of NGTS ART and develop capabilities that span user communities to meet those needs.

BENEFITS

Conducting standardized, formal debrief is something Naval Aviation communities pride themselves on for the teaching and learning of the warfighter. However, standardizing across platforms has been challenging; as we move to distributed LVC events the challenges will widen and the ability to conduct a standardized debrief across sites and platforms will increase resulting in lost learning opportunities and reduced training effectiveness. This effort aims to mitigate these risks by conducting analyses and development activities to ensure standardized debriefing across media and sites. Through standardization and sound methods, this effort will support optimized debriefing for improved training and readiness.

STATUS

In FY21 the team developed and piloted the analysis protocol. Piloting was conducted with NGTS users (operators, instructors, analysists) to determine preliminary requirements. The team is currently coordinating with the NADTC Atlantic Integrated Product Team (IPT) to begin full scale data collection.

MILESTONES

- Analysis protocol developed
- Pilot data collections conducted with NADTC operators
- Acknowledgment of support from NADTC Atlantic
- Full scale data collection to begin Q1 FY22

INVESTIGATING CROSS-DOMAIN ADAPTIVE TRAINING

OBJECTIVE

The goal of this effort is to perform research on the generalizability of adaptive training (AT) techniques for self-paced, rapid knowledge acquisition tasks across different domains. Specifically, we are planning to conduct a series of experiments using a flashcard-like interface to determine if AT algorithms that are effective in one domain extend to other domains.

Example flashcard in the experimental testbed.

PROJECT DURATION

DEC 2018 - DEC 2021

SPONSORS

Office of Naval Research, ONR-31

POINTS OF CONTACT

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DESCRIPTION

Adaptive training (AT) is training that is tailored to an individual's strengths and weaknesses, and it has led to higher learning gains and decreased training time when compared to traditional training approaches in certain domains. However, developing effective AT systems can be time-intensive and costly, and they are typically developed as one-off systems to address a specific training need.

The goal of this research effort is to determine the most effective and efficient instructional strategies for rote learning tasks and explore the generalizability of a common set of AT algorithms across different training domains.

NEED

The U.S. Navy and Marine Corps are focused on modernizing training for the information age by providing learner-centered training available at the point of need. In addition, they seek to reduce bottlenecks in schoolhouse training and find training opportunities for students awaiting training. AT is well-suited to meet this demand.

BENEFITS

This research has the potential to optimize classroom training time by allowing students the opportunity to practice skills on an individual basis, freeing up instructor time to focus on more challenging topics with the class. Additionally, this research will inform the military training community with evidence-based research on the effectiveness of domain-general AT techniques across different domains.

STATUS

In FY19, the research team designed a series of experiments to explore adaptive spacing and card dropping criteria and developed a flexible testbed that allows the research team to quickly implement new features, algorithms, and training content to enable experimentation. In FY20, the research team conducted AT experiments in collaboration with the Marine Corps Intelligence School and the Marine Corps Combat Service Support School. In FY21, the team completed 2 additional experiments to demonstrate the efficacy of generalizable adaptive algorithms to support rote learning in across multiple domains.

MILESTONES

- Developed Flexible Adaptive Sequencing for Training (FAST) testbed. FAST is a flashcard-based testbed in which researchers can manipulate AT algorithms to identify the most effective and efficient techniques to produce learning gains across multiple domains.
- Conducted evaluation of FAST as part of Automotive Maintenance Technician Basic Course at the Marine Corps Combat Service Support School. FAST included flashcards that covered 4 out of 8 automotive systems and over 160 learning objectives from the course. Students studied using FAST on their course-issued laptops during the 52-day course. Results showed that students who used FAST failed 50% fewer learning objectives on Annex 2 exams compared to a previous cohort without FAST.
- Conducted Experiment 1 in collaboration with the Marine Corps Intelligence School.
- Conducted Experiments 2 and 3 locally to follow up on Experiment 1 results. Collaborating with FIT to conduct Experiment 4.
- Published results at conferences: HCII 2020, HCII 2021, HFES 2021, Psychonomics 2021.

LIVE, VIRTUAL, CONSTRUCTIVE (LVC): AN INVESTIGATION OF THE LEGEND OF AVAILABLE DATA

OBJECTIVE

Examine application of data fusion, machine learning, and assessment techniques for both debrief and real-time decision aids for mission planning and replanning. Investigate data required and available to conduct real-time battle management assessment to support rapid synthesis of multiple courses of actions in the battlespace and feed human performance assessment and debrief for LVC.

Google Image of E-2D Live Aircraft

PROJECT DURATION

FEB 2020 - OCT 2022

SPONSOR

Office of Naval Research, ONR-34

POINTS OF CONTACT

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DESCRIPTION

The present effort seeks to build from a current Office of Naval Research Future Naval Capability: Fleet Adaptive Multilevel Measurement for Operational and Unit Systems (FAM2OUS). The proposed effort will expand the FAM2OUS applicability beyond Virtual-Constructive environments to Live, Virtual, Constructive (LVC), and eventually operational environments, by examining the application of data fusion, machine learning, and assessment techniques to support real time decision aids for mission planning and re-planning. Specifically, the Science and Technology (S&T) of this effort will focus on investigating the data required and available to conduct real-time battle management assessment in the LVC training environment to support rapid synthesis of multiple courses of actions in the battlespace and feed human performance assessment and debrief for LVC. Data and algorithms will be investigated to define both the pieces of data required for each measure and the means for synthesizing these data into meaningful output for instructor debrief and long-term trend analysis. These methods will be examined and expanded on to investigate their application to Battle Management Aids (BMA) for E-2D operators during real-time operations using the same data sources and synchronization of data in LVC for real-time decision making across platforms.

NEED

The high levels of coordination the E-2D is required to orchestrate for current and evolving tactics makes real time decision making complicated and dependent on large amounts of disparate data and inputs. However, despite the integrated role decision-makers play, the tools to dynamically assess, manage, and plan the battlespace are lacking, highlighting a gap in existing BMAs and planning tools. Thus, the need exists for tools that can be fed by the same disparate data sources and can populate real time feedback and debriefs in LVC environments.

BENEFITS

Real-time BMA provides operators with improved situational awareness and a more critical analysis of options resulting in improved warfighting performance. Additional data sources fused for debriefing provides a more comprehensive diagnostic picture of performance, improving the quality of instruction, increasing proficiency and readiness. This will also enable trend analysis and comparison from live and VC training.

STATUS

In FY21, development of fusion algorithms for synthesizing data is planned, interface and display for BMA and debrief capabilities based on available data and user needs is planned. These developments will be demonstrated later in FY21.

MILESTONES

- Preliminary data collection with E-2D SMEs: Tactical Training Group Pacific Q1 FY20, VAW120 10FEB 2020
- Identification of warfare center partner in May 2020
- Kickoff held Q3 FY20
- Investigation of Resource Allocation Algorithm's applicability to the Air Defense domain underway

VIRTUAL OBSERVER CONTROLLERS FOR ADAPTIVE TRAINING (VOCAT) (OSD11-CR1)

OBJECTIVE

Automated adaptive assessment and instruction to trainees within a denied and degraded collective, LVC training environment. Specifically, contractor (Discovery Machine Interactive or DMI) will deliver a software application and mentor dashboard called ZARATAN: Zulu Adaptive Reasoning Advisor and Training Agent for the Navy.

ZARATAN Mentor Dashboard Screen Capture

PROJECT DURATION

OCT 2019 - AUG 2020

SPONSORS

Office of Secretary of Defense
Small Business Innovation Research (SBIR)
PMA-205

POINTS OF CONTACT

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DESCRIPTION

For VOCAT, the SBIR performers developed intelligent agents having situation awareness and decision processes mapped in software via knowledge representations. In addition, VOCAT has a supplemental ontology representing the training objectives and cues.

NEED

Individualized instruction is vital in complex decision-making environments such as Anti-Submarine Warfare (ASW) and Anti-Access/Area Denial (A2/AD) domains where trainees need to be prepared for situations that are highly varied and where needed assets or communications are unavailable. Today, instructors must fabricate realistic situations in simulations in which to immerse the trainee. These highly dynamic environments often require numerous actors or "pucksters" who take on the roles of the opposing forces, so the instructor's job becomes one of orchestration rather than instruction.

BENEFITS

The adaptive training solutions developed under this effort will extend the science of real-time adaptive training for the Navy by creating a unique virtual observer/controller (VO/C) approach to guide and evaluate trainee performance. The innovative VO/C was developed with expert training knowledge of optimal task performance that can simultaneously track and evaluate multiple potential task sequences at varying threshold levels for a given individual. This allows not only for complex tasks where optimal performance may be represented by two or more tasks, but also allows for evaluation based on experience level, where novices may be allowed larger tolerances early in the learning to afford experiential learning.

STATUS

The ZARATAN application and dashboard was completed and delivered Aug 2020 to Naval Simulation Center Pacific NSCPAC (San Diego).

MILESTONES

- Research on speech recognition engines and natural language processing technologies was documented in the Phase II final report and could be used with Fleet chat applications. Additional transitions are being sought via the Navy supported Joint After Action Review (JAAR) application and Naval Surface Warfare Dahlgren Division Dam Neck Annex (NSWDDC DNA).
- FY19Q3: Developed VOCAT Dashboard Framework - which allows for customizable user interfaces driven by intelligent agents
- FY20Q2: Expanded JAAR integration allowing automatic generation of High Interest Events (HIE) and visualization in VOCAT Dashboard
- FY19-20: Developed ZARATAN User Interface for Zulu mentor dashboard that will support mentor assessment and monitoring of LVC events.
- FY20Q1 and FY20Q2: Participated in two V&V events that resulted in refinement and testing for ZARATAN capabilities.
- Aug 20: Phase II Final Report

ARTIFICIAL INTELLIGENCE (AI) FOR ANTI-SUBMARINE WARFARE (ASW) TRAINING (N202-091)

OBJECTIVE

Implement a tactical and evolving Anti-Submarine Warfare (ASW) application with AI technology, specifically the application of AI technology to passive ASW analysis. AI augmentation should be aggressively pursued to increase the manning and training aspects of the AO (operational availability) equation across the Navy.

P-8A Poseidon, an Anti-Submarine Warfare aircraft

PROJECT DURATION

OCT 2020 - JAN 2024

SPONSOR

NAVAIR Small Business Innovation Research Program (SBIR)

POINTS OF CONTACT

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DESCRIPTION

This SBIR project seeks a phased approach to implementing a tactical and evolving Anti-Submarine Warfare (ASW) application with AI technology, specifically the application of AI technology to passive ASW analysis. The early system will demonstrate a form of explainability and confidence values in outputs provided. Future iterations of the system will include self-tuning algorithm parameters. Performers will be developing a proof-of-concept system that will demonstrate the feasibility of the proposed training capability within an undersea (or relevant) domain with publicly available training data.

NEED

Acoustic operators go through approximately two years of initial training including hands-on training and years of additional submarine contact time in order to build proficiency. With additional capabilities of the Maritime Patrol community coming online, the demands on a given acoustic operator have only increased. With these increased demands, we must recognize the limitations of human acoustic operators when analyzing acoustic data, especially before initially locating a subsurface target, when unsure of when and where contact will appear. As human beings, they can only apply their cognitive process to information from a single sonobuoy at a time. Experience and training may allow the operator to process the information faster and more accurately, but their capacity is still limited.

BENEFITS

Trained AI can assist AWOs in the training and operational context. Confidence values with those explanations would further involve the human trainee in the situation. Flag officers have recently requested that information that AI systems output should come with a confidence factor as standard practice. Although the trainee would have the final say in all matters, the AI can help scaffold the training so that the trainee has useful information about multiple different variables, and the reasoning why confidence values are what they are.

STATUS

One contractor from Phase 1 was invited to submit a full Phase 2 proposal to be awarded in early 2022. Work will focus on transitioning the Phase 1 prototype that emphasized Active sonar, to process passive sonar in Phase 2. Furthermore, the team will look to incorporate real-world data in addition to high-fidelity simulated data.

MILESTONES

- Phase 1 kickoffs held in late 2020
- Phase 1 closeouts will take place in January 2022
- Phase 2 will be awarded in early 2022
- Accepted for conference presentation at the 2021 Undersea Warfare Fall Conference in October 2021
- Technical interchange meeting conducted at NAS Jacksonville with project stakeholders (September 2021)

DESIGNING NON-PLAYER CHARACTERS (NPC) FOR INDIVIDUALIZED INSTRUCTION IN ELECTRONIC WARFARE TRAINING SYSTEM (BAR-21-022)

OBJECTIVE

This effort seeks to empirically validate the use of non-player characters (NPCs) for providing instructional interventions to trainees in adaptive training systems. As an instructional feature, NPCs often resemble tutors that facilitate knowledge acquisition by providing feedback and interaction with trainees during their training experience. Expanding on our previous work with NPC designs in EW adaptive training, this effort seeks to understand in what contexts NPCs are most effective in adaptive training, while simultaneously developing diagnostic algorithms to support the effectiveness of NPC-delivered feedback.

Notional feedback algorithm output, showing detailed feedback to trainee (with NPC narrations)

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR

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DESCRIPTION

Non-Player Characters (NPCs) are computer-controlled characters that often take the form of an instructor in a training system. Previous research suggests that NPCs facilitate immersion, engagement, and motivation, which subsequently aids learning. This effort adopts a scientific approach to examine the potential short- and long-term learning benefits of training an applied task (Electronic Warfare – EW) with an NPC to provide feedback. Part of this effort will analyze previous data collections with our EW training system to identify task components that would be suitable for feedback. This analysis will support the development of an automated, tailored feedback algorithm, which will drive the NPC's feedback delivery to the trainee. After accomplishing these development goals, we will test the effectiveness of feedback algorithms and NPCs with a research experiment, assessing learning in the short-term and long-term. Additionally, we will examine related factors (such as immersion, engagement, and motivation) to better understand how NPCs can benefit learning. Looking forward, a goal of this effort is to ensure that any improvements we develop (e.g., feedback algorithms, NPC best practices) transition upward into our existing Fleet EW training systems.

NEED

The Navy has emphasized improving the warfighter's ability to monitor the electromagnetic spectrum. The EW Wholeness Campaign has stated that training is needed which can "rapidly improve experience levels of current EW operators." In order to address these concerns, improved training is one of the campaign's primary pillars. Therefore, training is needed which can rapidly improve the experience level and proficiency of current EW operators. The outcome of this effort would directly support the training pillar of the EW Wholeness campaign by providing evidence for the inclusion of advanced instructional techniques in EW training systems.

BENEFITS

This research will help to understand not only an NPC's role in knowledge acquisition, but also the longer-term effects on retention. If the NPC serves to make training more engaging and immersive while also improving learning outcomes, and helps trainees retain their knowledge after time away from training, then this would be an effective instructional strategy to implement. Understanding how best to implement NPCs in training systems will help the Navy build more effective and efficient training without increasing overall training costs, time, or number of instructors. The findings of this body of research are expected to improve training effectiveness and mission performance across a broad range of tasks and missions. For instance, while this research is using a UAV-inspired research task, its findings will be applicable to air, surface, and undersea platforms. In particular, the algorithms developed in this proposal could immediately transfer to our currently deployed systems under the Electronic Warfare Micro-adaptive Trainer (EW-MAT) program.

STATUS

In FY21, the research team developed the NPC instructor, along with feedback algorithms to support instruction selection. We developed narrated instructional videos for several electronic warfare subtasks, which can be triggered depending on user inputs and performance data while training. The team developed an experimental research protocol and obtained IRB approval to begin collecting data in FY22. The team will analyze these data to scientifically evaluate the efficacy of NPC instructional interventions.

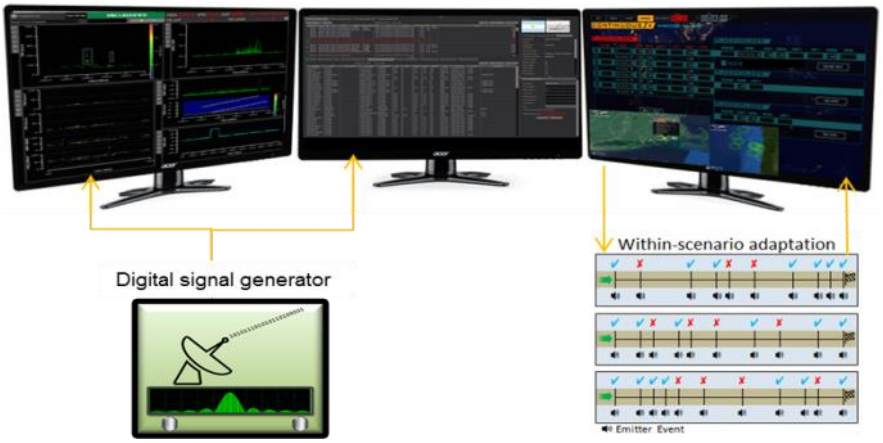
MILESTONES

- In FY21:
  - ◊ Developed conceptual framework for NPC instructional interventions
  - ◊ Finalized instructional algorithms with the support of prior data collections
  - ◊ Prepared detailed experimental plan and obtained IRB approval to conduct research
- In FY22:
  - ◊ Collect experimental data
  - ◊ Develop transition plan with customer to transition instructional algorithms to on-board and schoolhouse training
  - ◊ Prepare results for publication and conference presentation

ELECTRONIC WARFARE-MICRO ADAPTIVE TRAINING (EW-MAT)

OBJECTIVE

The main objectives of this Future Naval Capability (FNC) are to (1) create validated micro-adaptive training algorithms to diagnose the strengths and weakness of operators in real time as they perform actions using the on-board tactical system, (2) develop a digital signal generator that will inject realistic signals in an on-board trainer, (3) evolve the state-of-the-art in EW hardware and software to create a common EW framework for air, sea, and undersea platforms.



PROJECT DURATION

SEP 2017 - DEC 2021

SPONSORS

Office of Naval Research, ONR-31

POINTS OF CONTACT

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DESCRIPTION

The research team will develop a training architecture within ONR's Rough Squid Electronic Warfare (EW) Sandbox that allows operators to perform actions using the on-board tactical system hardware/software. The architecture will support a digital signal simulator to inject realistic and robust signals representative of advanced EW sensors along with micro-adaptive training algorithms to diagnose the strengths and weaknesses of operators in real time during training.

NEED

Submarine EW operators provide critical, time-sensitive information for maintaining ship safety and avoiding counter-detection. Yet there is no current capability for embedded, on-board adaptive training for EW operators. As described by the Submarine Force Electronic Warfare Wholeness Campaign, training is needed which can "rapidly improve experience level of current EW operators." Furthermore, the Submarine Tactical Requirements Group (STRG) recently has recommended Adaptive Training (AT) to fulfill critical training gaps (requirement STRG-TRG-.0(1)).

BENEFITS

Research has demonstrated that AT systems lead to improved performance while requiring less training time. These outcomes provide the potential to enhance training for submariners by improving the Navy's ability to provide tailored, individualized instruction to operators, and therefore enhancing readiness, without increasing the Submarine Force's overall training costs, time, or number of instructors. Additionally, investing in a cross-platform training solutions (e.g., the digital signal generator), will lead to more highly trained operators in the Fleet capable of managing increasingly complex RF environments. Thus allowing the Navy to maintain its maritime superiority and decisive edge.

STATUS

The first major development thrust involves expanding upon the adaptive training service modules, scenarios, network interfaces, and user interfaces that were developed in the Submarine EW Adaptive Trainer (SEW-AT) effort and incorporating them natively into Ghost Rider Analyst Spectrum Publisher (GRASP). Additionally, we are tackling several S&T challenges including the appropriate design of AT (in terms of instructional content and adaptive scheduling) and its performance impact/training value.

MILESTONES

- Demonstrated SEW-AT to PEO Submarines and PEO IWS5 on 13DEC19
- Invited to participate in the Submarine EW Tactical Advancements for the Next Generation (Sub EW TANG) Training Community Day on 18FEB20. The team presented program status and provided a SEW-AT demo to PMS-435, UWDC, SLC, etc.
- Completed implementation of experimentation testbed and began data collection on first experiment (of two) to address S&T challenges associated with adaptive scheduling and goal-setting feedback.
- Designed the EW Report Human Machine Interface that will be integrated into the AN/BLQ-10 tactical system.

INCREASING AVIATION READINESS FOR SUBMARINE PROSECUTION WITH HIGH FIDELITY TACTICAL PERFORMANCE DATA & TRENDS

OBJECTIVE

The objective is to provide the Maritime Patrol Reconnaissance Force (MPRF) with comprehensive, high-fidelity, filterable, and tagged real-world submarine prosecution data within the existing SIPR post-mission database system, Post Mission Assessment for Tactical Training and Trend Analysis (PMATT-TA).

Improving anti-submarine warfare training requires collecting higher quality data

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: Tech Transition

POINTS OF CONTACT
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DESCRIPTION
Advanced analytic technologies leveraging the cloud, artificial intelligence, and data science are only as effective as the quality of the data they synchronize, integrate, and analyze. A challenge with implementing these technologies is the reliability, validity, quality, and gaps in the underlying data. This effort will conduct a technical analysis of the current fidelity of high-impact prosecution data, identify missing critical data sources, and pursue opportunities to increase data quality and availability to the MPRF. The goal will be to demonstrate critical performance parameters of data analytic software for post-mission reporting that is currently complicated by each Fleet having different reporting requirements and repositories, and spanning multiple areas of Operation that make standardization and tracking difficult.

NEED
With the prevalence of big data analytics and artificial intelligence throughout the Department of Defense, there's a scientific urgency to ensure these efforts are setup for success early.

BENEFITS
Success of this effort will enable the MPRF community, and associated organizations, access to full PMATT-TA timelines and data sets of their most relevant and critical Anti-Submarine Warfare events. Enabling full trend and tactical analysis transparency will inform decision makers with highly relevant real-world data and can allow them to further develop training to ensure limitations are being addressed and fulfilled. Members of the MPRF community are already taking stock of what data sources they have access to, in order to try and answer tactical and training questions. Although data exists, it resides in multiple data repositories, with varying levels of fidelity and quality; organizing and ensuring high fidelity data is critical.

STATUS
Year one focused on identifying a recent high-priority prosecution, conducting a gap analysis based on the availability and location of required data, and compiling a master flight/event list for prosecution 1. Future tasking will include conducting pre- and post-implementation analysis and reporting based on current data availability and fidelity and then identifying data tagging and filtering procedures within PMATT-TA.

MILESTONES

- FY 21: Identification of one recent high-priority prosecution timeline
- FY 21: Fleet discussions to determine pre-implementation analysis and reporting
- FY 21: Conducted initial gap analysis based on availability and location of required data
- FY 22: Conduct post-implementation comparative results analysis to show the benefit of high-fidelity input
- FY 22: Expansion of year-one work to include additional prosecution timelines
- FY 22: Final report to provide stakeholders with comparative results, as well as recommendations and lessons learned

FUTURE INTEGRATED TRAINING ENVIRONMENT (FITE)

OBJECTIVE

The purpose of the FITE effort is to meet the needs and demands of the United States Marine Corps (USMC) by addressing the technical challenges associated with linking air and ground simulations for providing integrated training capabilities. The FITE effort enables existing and future disparate simulation components to communicate efficiently and operate together in an integrated manner to enhance warfighter capability with a specific focus on Close Air Support (CAS). This effort also develops virtual reality integrated training solutions for Joint Terminal Attack Controllers (JTAC).

FITE Integrated Virtual Reality Training solutions for Close Air Support: JTAC Virtual Trainer (left), Viper Virtual Trainer (right)

PROJECT DURATION

JAN 2017 - MAR 2021

SPONSORS

Office of Naval Research
ONR-34

POINTS OF CONTACT

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DESCRIPTION

The FITE effort supports the USMC Live, Virtual, and Constructive-Training Environment (LVC-TE) program by addressing the technical challenges associated with linking air and ground simulations. FITE is comprised of two main components: the Synthetic Battlespace Service (SBS) and the Synthetic Environment Service (SES). FITE SBS provides an extensible service that allows dissimilar simulation components to effectively interact with one another in real-time, based on what each simulation requires for the training event. FITE SES synthesizes and fuses terrain generation capabilities across dissimilar simulation systems to facilitate an integrated and interoperable training environment. The FITE effort has also developed the JTAC Virtual Trainer (JVT) that provides portable training for JTACs in a virtual environment that can utilize SBS to provide integrated training capabilities.

NEED

USMC Leadership, via a Deliberate Universal Needs Statement (DUNS), expressed a requirement for a distributed mission operations (DMO)-capable training simulator capability for JTACs, Joint Forward Observers, pilots, and aircrews to train effectively in a common, simulated operating environment. This requirement is also reinforced by the Marine Air Ground Task Force (MAGTF) Fires Operational Advisory Group (OAG) Tactical Air Control Party (TACP) Simulation recommendation to have "full TACP simulation interoperability and interoperable distributed mission training with Aviation Combat Element (ACE) and Joint Systems."

BENEFITS

This effort will enable existing and future disparate simulation components to communicate efficiently and operate together in an integrated manner to meet the training needs and demands of the USMC fires community and leadership.

STATUS

The current FITE system includes the integration/interoperability of the USMC Deployable Virtual Training Environment – Combined Arms Network (DVTE-CAN) and Virtual Battlespaces (VBS), the JTAC Virtual Trainer, and the ONR Warfighter Augmented Reality (WAR) system. Throughout FY20, significant progress was also made on FITEware Adaptors (for bridging, filtering, and enumeration conversions), the JVT, terrain generation, maintaining the Set-Repo terrain repository, and dynamic environment services. Many demonstrations and interactions have occurred with USMC stakeholders and users communities.

The remainder of the effort will focus on exit criteria testing and incorporating FITEware SBS and SES technologies into the USMC LVC-TE Program of Record for transition. The team will also conduct an evaluation event for JVT at MAWTS-1 in Jan 2021.

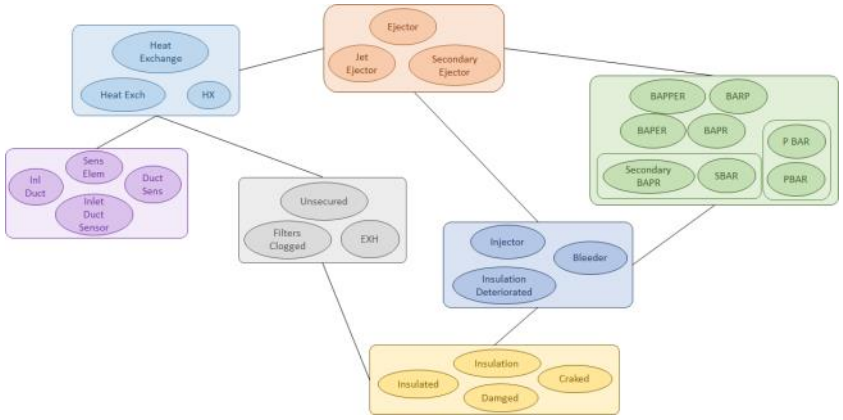
MILESTONES

- Demonstrations, training and interactions at: 10th Marines, 11th Marines, 29 Palms Battle Sim Center, MAWTS-1, 1st Anglico, School of Infantry West, School of Infantry East, I/ITSEC, EWTGPAC, EWTGLANT, LVC-TE, and OASIS
- 20+ JTAC Virtual Trainer prototypes and/or FITEware software deliveries deployed to various USMC organizations
- Launched set-repo.org for sharing high fidelity virtual terrains
- Delivered FITEware to the LVC-TE team to begin Exit Criteria testing

LEXICAL NORMALIZATION TO FACILITATE INFORMATION EXTRACTION OF NAVY TEXT (BAR-20-025)

OBJECTIVE

Develop and evaluate Navy-specific unsupervised Natural Language Processing (NLP) models to improve the handling of domain specific terms, abbreviations, and anomalies that are present across Navy enterprise free text responses, such as maintainer logs. The second objective is to evaluate the ability of the resulting trained models to generalize to other Navy text domains.



Representation of lexical relationships of some Navy-specific language.

PROJECT DURATION

OCT 2019 - SEP 2021

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR

POINTS OF CONTACT

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DESCRIPTION

Proven unsupervised NLP models for Navy text facilitates faster information extraction from maintenance logs. First though, the text must be cleaned (e.g. identify acronyms, fix typing errors) then semantic meaning must be extracted. These will enable identification of the documented reason for the maintainer action, what action they took, and what aircraft part(s) were involved in that action. These tasks can be embedded within a larger system for more robust identification of patterns within other corpora. Increasing robustness and thoroughness in the analysis of aircraft health and maintenance actions is necessary to transition towards prescriptive maintenance.

NEED

The Navy produces significant amounts of unstructured, human-generated text that contains issues (e.g., typos in maintenance reports and repetition in training) that are roadblocks to making use of automated techniques for search and understanding. Supervised training methods can be costly, especially if repeated across domains. Unsupervised models that can generalize across Navy domain spaces can reduce cost and provide greater use case opportunities. The resulting unsupervised NLP algorithms generated and proven by this effort will improve and broaden the use of advanced machine learning applications on Navy text data.

BENEFITS

These models will improve the extraction of information for effective search and understanding of the data, and enable the effective use of the data within machine learning applications.

STATUS

Developed a Navy-specific tokenization, feature extraction, and synonym identification modules NLP library and uploaded to Navy code sharing site (https://spork.navair1.navy.mil/). This effort was completed in FY21.

MILESTONES

- FY20:
  - Implement unsupervised algorithms for lexical normalization
  - Evaluate lexical normalization models on tagged text
  - Present results at Navy Applications of Machine Learning workshop
  - Build Natural Language Processing library code for others to use
- FY21:
  - Evaluate tokenization algorithms on tagged Navy text
  - Evaluate document embedding algorithms
  - Customize text feature extraction code for Navy text
  - Update library code with best results
  - Author technical report
  - Developed NLP library and uploaded to Navy code sharing site

MARITIME PATROL RECONNAISSANCE AIRCREW COMMS TRAINER: RADIO OPERATIONS GUIDANCE AND EDUCATION RESOURCE (ROGER)

OBJECTIVE

Develop a prototype web-based application to facilitate instructorless radio communication training. Develop a basic-to-advanced training technology that provides access from early Category 1 students to post-Fleet Replacement Squadron (FRS) training to complement existing training solutions.

ROGER Prototype Testing and Demonstration Event at Jacksonville, FL

PROJECT DURATION
JUN 2019 - AUG 2021

SPONSOR
Office of Naval Research (ONR)
ONR Global: TechSolutions

POINTS OF CONTACT
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DESCRIPTION
The Maritime Patrol Reconnaissance Aircraft (MPRA) community identified a skill gap in proper and efficient radio communication. Despite heavy reliance on chat communications within U.S.-only operations, voice remains predominant in cross-domain and multi-national operation. This effort seeks to design and develop a web-based application with a simple user interface that provides a capability to listen to good examples of communications of specific report types. The technology focuses on communication completeness and brevity, with a focus to automatically assess language disfluency.

NEED
There is a lack of radio communications-based training for the MPRA community. Though Crew Resource Management and inter-aircrew communication are a focus of current individual and team training environments, there are limited opportunities to engage in training communication skills with other airborne, command and control, or tasking agencies in the current curriculum.

BENEFITS
The development and continued iterative testing of ROGER will provide VP-30 early Category 1 Co-Tactical Coordinator (COTAC) students to post-Fleet Replacement Squadron (FRS) Aircrew a program to practice and gain experience delivering brief and clear radio communication, without the need for an instructor. The prototype system allows students to practice in an increasingly more robust tactical environment, which can be expanded in the future to include realistic interfaces and voice-interactive role-players.

STATUS
FY19-20 efforts focused on the design and development of the web-based ROGER prototype, including the capability to analyze and store structured automatic speech recognition (ASR) results. Three courses developed demonstrate the range of content capabilities. FY21 delivery and testing of the ROGER prototype are underway. Future work includes expansion of speech analysis capabilities, performance assessment and learning management, and end-user scenario authoring.

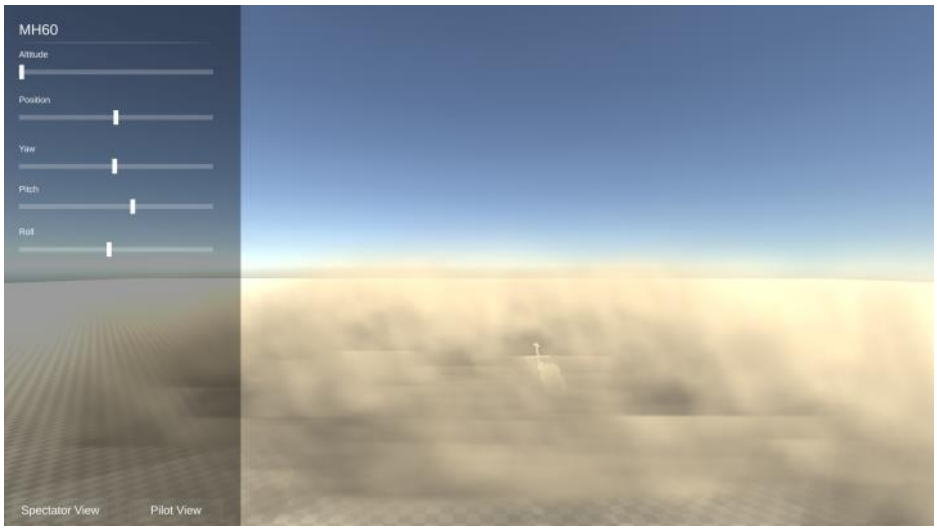
MILESTONES

- Project meetings to evolve design including a Preliminary Design Review (SEP 2019) and Critical Design Review (DEC 2019)
- Awarded an Indefinite Delivery Indefinite Quantity (IDIQ) contract for cybersecurity support (AUG 2019)
- A Technology Transition Agreement (TTA) was signed by NAWCTSD, the Small Business Innovative Research (SBIR) office, and PMA -290 to support a cluster of three (3) parallel Phase II efforts to research and develop modular technologies for ROGER
- Iterative system testing and development was conducted throughout the project to refine the system, including an initial system demonstration and review (FEB 2020) and a virtual Fleet demonstration (JUN 2020)
- Initial informal usability testing conducted to refine system user interface (AUG-SEP 2020)
- Demonstration and testing events with stakeholders and fleet personnel (OCT20-DEC21)

MISHAP AWARENESS SCENARIOS AND TRAINING FOR OPERATIONAL READINESS RESPONSES (N172-117): WING MISHAP AWARENESS NARRATIVES (WINGMAN)

OBJECTIVE

Develop a customizable software program that provides outputs to result in a suite of training tools and technologies that support recreation of aviation mishap events to convey lessons learned and improve safety training through classroom based videos and interactive, immersive visualization techniques.



User interface Demonstrating Development of Brownout/Whiteout Scenario.

PROJECT DURATION

SEP 2017 - FEB 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

POINTS OF CONTACT

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DESCRIPTION

Advances in virtual reality and computer graphics make it possible to create a software program that allows the user to set a scenario based off of mishap data to recreate mishap events for training leveraging a range of media. The Navy seeks a single scenario development technology that provides inputs to develop a range of training opportunities that are consistent and require minimal investment by the program to continue to expand mishap training scenarios. This system should allow for the development of new scenarios, as well as provide an ability to modify previously created scenarios within the tool through a simplified user interface.

NEED

Spatial disorientation (SD) and situational awareness (SA) are significant contributing factors to the majority of aviation mishap events. The aviation survival training community has requirements to provide sensory physiology/situation awareness training; however, the current training is predominantly classroom-based instruction that leverages videos that are not easily updated as new platforms or situations occur.

BENEFITS

Providing a more immersive range of training opportunities will allow for more trainee experience and engagement and likely improve the fidelity and appropriateness of the training. Operator performance will also increase through the ability to better recognize and/or implement emergency procedures when experiencing SD/SA situations, creating safer and more effective warfighter operations.

STATUS

This SBIR has undergone competitive source selection resulting in a single Phase II effort: WingMAN. The development team has continued to refine the scenario authoring tool based on end-user feedback to increase usability and increase efficiency. System capabilities have been expanded with support for 360 video export. Continued development of baseline scenarios continue and include lead aircraft roll illusion, black hole illusion, and reduced/absent visual cues scenario.

MILESTONES

- During Phase I efforts, kickoff meetings were held with four (4) vendors, closeout briefs including technology demonstrations; as a result of performance, a gated Phase II approach was selected resulting in award of three (3) Phase I Options
- Phase II base efforts included kickoff meetings and Phase II base out brief meetings with three (3) vendors to include demonstrations of prototype capabilities with aviation survival training end users (AUG 2019) to evaluate progress for selection of option funding
- Technology demonstration was provided to Rear Admiral Luchtman (FEB 2020)
- Phase II option funding was provided to a single vendor, who continued development efforts in FY20 and conducted a virtual demonstration and status update to stakeholders in NOV 2020
- Phase II option two funding was awarded with in progress review scheduled for DEC 2021

MOBILE AVIATION SURVIVAL TRAINING CENTER APPLICATION AND SMARTBOARD SCENARIO-BASED TRAINING TOOLBOX (219TT-RPC-007)

OBJECTIVE

Provide a mobile technology architecture for students and instructors to modernize and augment current survival training by allowing users to access domain-relevant content on topics to reinforce classroom and lab training solutions. Instructor capabilities will include authoring new modules, and easy assessment of student needs and feedback.

Students Receiving Instruction on Basic Parachute Landing Techniques

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: RPC

POINTS OF CONTACT

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DESCRIPTION

The aim is to design a web-based application to include course content including specific scenario-based training to students, highlighting real-life occurrence bailouts to hold discussion-based lessons. The proposed baseline technology provides a lightweight, web-deployable training system that is capable of supporting adaptations based on trainee performance. This aspect of the system provides flexibility to support both instructor led as well as instructor-less training capabilities that can adjust based on implementation needs. Additionally, this training tool will include an authoring mechanism for instructors to create supplemental lessons to enhance classroom learning.

NEED

The aviation survival training community currently has no means for reinforcing the survival training that occurs once every four years, nor do they have a means for developing training content that is current and collecting feedback from trainees on the effectiveness of the training. The mobile application is intended to directly address these three areas of need.

BENEFITS

The mobile application has the potential to advance aviation survival training by providing a means to reinforce the training that happens infrequently. Thus, the application has the potential to save lives by ensuring aviators are well equipped to deal with emergency scenarios. Additionally, the application offers a means for the continual advancement of survival training at the Aviation Survival Training Centers (ASTC) by offering training effectiveness assessments and content-generation capabilities.

STATUS

The project team established Adaptive Perceptual and Cognitive Training System (APACTS) testbed. A Request for Advisory was submitted which met the criteria to be considered human subjects research. A prototype requirements and priorities survey was sent to SMEs at the Aviation Survival Training Center (ASTC) to inform project requirements; analysis of results was completed to inform initial priorities and guide use case development. Developed mockup designs based on the feedback provided by SMEs to outline initial design, functionality of lessons, and activities in the proposed system design. Identified and organized content to assist with scoping and produce storyboards based on the initial mockup designs, as well as to provide relevant content for proof of concept demonstration. Developing plan to assess functionality and content with subject matter experts to guide development focus.

MILESTONES

- Year 1: Develop system architecture and provide report of relevant course material to be integrated into the system
  - Stakeholder engagement in refining requirements and selection of use case for prototype development including collection and analysis of survey inputs on curriculum areas that would benefit from alternative technology capabilities
  - Leverage technology developed by industry partner under ONR FNC effort and being expanded under SBIR efforts to develop a preliminary testbed for development and testing
- Year 2: 1) Conduct usability study on the mobile application and scenario-based training toolbox to finalize the system architecture and provide a prototype demonstration to the ASTC in Pensacola, 2) document results of Fleet experimentation on system effectiveness, lessons learned, and recommendations and 3) Concept of operations (CONOPS) documentation

MULTI-DOMAIN DATA FUSION INSTRUCTIONAL STRATEGIES AND METHODS (N202-112)

OBJECTIVE

Research and develop training objectives for the multi-domain environment and instructional strategies for manned-unmanned data fusion tactical decision making. Research and develop instructional tools that support defined strategies and methods to increase operator training effectiveness and mission readiness.

The V-280 Valor performs a flight demonstration in Arlington, Texas, Oct. 28, 2020. In 2014, the Army selected Sikorsky-Boeing and Bell teams to continue the Joint Multi-Role Technology Demonstrator (JMR-TD) to flight demonstration proving out transformational vertical lift capabilities while burning down risk for Future Vertical Lift efforts.

PROJECT DURATION

OCT 2020 - JAN 2023

SPONSOR

NAVAIR Small Business Innovation Research Program

POINTS OF CONTACT

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DESCRIPTION

Operator reliance on sensor fusion is becoming more prominent as platforms increase reliance on automated technology in next generation platforms. Further, as programs look to extend platform capabilities through off-board, unmanned sensor technology and capabilities, requirements for operator synthesis of data and decision -making based on manned-unmanned collaboration will become an essential part of operations. As these technologies advance, training systems must identify appropriate instructional strategies and training methods to ensure that operators understand the implications of automated technologies.

NEED

As the Navy increases the use of data fusion technology on manned and unmanned platforms, the operator must have appropriate training and sound human factors interfaces to increase safety and operator performance. Further, the multi-domain nature of the future battlespace requires technology to fuse data from multiple heterogeneous sensors with overlapping coverage areas, which increases the complexity of interpretation of data outputs for operators. These emerging capabilities create new training challenges that must be addressed early in the training cycle.

BENEFITS

Increased efficiency of training via targeted instructional strategies and sound human factors interfaces would increase transparency of automated systems in a way that will minimize workload impacts, resulting in increased operator performance. Additionally, advanced instructional strategies and training methods will ensure that operators understand the implications of advancing automated technologies.

STATUS

Under the Phase II efforts, the team is pursuing an effort to support the Navy/Marine Corp's Future Vertical Lift (FVL) Navy Future Long-Range Assault Aircraft (FLRAA) program. Through the use of workload modeling, simulation training, and automation the team is exploring a Learning Management System capability to help future aviators better understand and effectively use artificial intelligence as it applies to the needs of next generation Navy missions and beyond.

MILESTONES

- Evaluated proposals during competitive source selection to award 3 Phase I contracts
- Phase I SBIR contracts awarded OCT 2020 to (3) companies.
- Kickoffs conducted with stakeholders in OCT 2020
- Down-select through evaluation of Phase I reports, Phase II initial proposals, and demonstrations to result in selection of single Phase II awardee
- Engagement with program office stakeholders including PMA-276 and PMA-205, as well as joint Future Vertical Lift program offices

NAVAL AIR TECHNICAL TRAINING CENTER (NATTC) AIR TRAFFIC CONTROL FUNDAMENTALS LAB

OBJECTIVE

Build, test, and deliver a new Air Traffic Control Fundamentals Lab Trainer, which will be utilized for Air Traffic Control "A" school (ACA1) located at NATTC, Pensacola, FL.

PROJECT DURATION

APR 2019 - SEP 2021

SPONSORS

Naval Aviation Training Systems Program Office, PMA-205
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: Tech Transition

POINTS OF CONTACT

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DESCRIPTION

The new training system will allow the airfield, aircraft, and ground vehicles to be visualized in a virtual environment. The system will allow highlighting of aircraft, airfield features, and vehicles to help target class discussion and focus on the specific aspects of the training. An Instructor Operator Station (IOS) will be created to allow instructors to dynamically create/load scenarios. The system will be able to play, pause, and resume scenarios, allowing them complete control of the scenario to add discussion points during training.

The system will allow multiple roles to be played simultaneously, allowing more than three students to participate in training at a time. This will actively engage more of the class and allow the students to greatly increase their hands-on time with the system. The system will include speech recognition for student phraseology, which will allow trainees to practice their voice commands without increasing instructor workload. This tool could also be broken off as a standalone system for afterhours practice. The system will include the communications and VIDS systems, so students can learn what they would expect to see when they transition to the tower simulator.

NEED

The current Air Traffic Control Static Lab requires instructors and students to physically move models of aircraft and vehicles around a table top depiction of an airfield. The trainer does not have role player automation, the ability to train phraseology, and trainer capacity is limited to three students (out of 14) at a time. These deficits have led to delays in student skill acquisition (e.g., inability to complete the advanced tower simulator) and increased training attrition rates (currently at 37%).

BENEFITS

With an average of 650 students trained per year, the high attrition rates are not sustainable. This updated trainer will increase trainer efficiency, reduce instructor workload, and give students five times more hands on practice time during Phase 1 of training. This coupled with earlier introduction to ATC Tower tools like the radar, VIDS, and EVTS systems, will increase student performance in Phase 2 of ATC Training and reduce the attrition rates for the overall course.

STATUS

A prototype of the trainer was developed and demonstrated in the lab in FY19. The team installed the trainer at the schoolhouse in FY20 and will be targeting IOC after the first quarter of FY21 and FOC by the end of FY21.

MILESTONES

- Prototype for NATTC Review 4th Quarter FY19
- Initial Operational Capability FY20
- Final Operational Capability FY21

ON-DEMAND TRAINING SOLUTIONS FOR MAINTENANCE TECHNICIANS (N193-D01)

OBJECTIVE

Develop an adaptive training environment with integrated capabilities to assess performance of skills that is scalable to operational maintenance department training needs and flexible to instructor-in-the-loop to instructor-less practice.

Aviation Machinist performs maintenance on an MH-60S Sea Hawk assigned to the "Sea Knights" of Helicopter Sea Combat Squadron (HSC) 22 aboard USS Detroit (LCS 7)

PROJECT DURATION
AUG 2020 - AUG 2022

SPONSOR
NAVAIR Small Business Innovation Research Program (SBIR)

POINTS OF CONTACT
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John Hodak (PM)
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DESCRIPTION
Sailors will commonly go through "A" school and "C" school to receive advanced training and earn a Navy Enlisted Classification (NEC), only to spend years away from the system they were taught to maintain. This is often the case when Sailors go to shore duty, and then return to the operational unit where the skills they had have eroded. While the Navy is working toward extending first shore tours to provide more experience to maintainers early in their careers, providing on-demand capabilities throughout the training pipeline to include operational tours is critical for minimizing skill decay, and ensuring proficiency at the time skills are required.

NEED
Rear Adm. Roy Kelley stated that Class C mishaps have doubled in the Navy since 2012 and involve upwards of $50,000-$500,000 in damages or nonfatal injuries. Ensuring maintainers have the tools required to react to maintenance issues is a crucial part of addressing the cause-or-effect relationship maintenance has in mishap incidence. Previous efforts by the Navy to invest in readiness-builders, including increased inventory of spares, maintenance, and logistics, have shown positive gains. However, investment in ready, relevant training solutions and capabilities for assessing performance of skills are necessary.

BENEFITS
An on-demand training solution will provide maintenance technicians refresher training capabilities on topic-based and standardized recurring training at the squadron level. This would also save training dollars and improve readiness. Introduction of training at this level fills a gap associated with infrequent maintenance tasks, complex maintenance repairs, and emerging recurring maintenance trends.

STATUS
This effort is currently in Phase II, with two (2) vendors developing alternative technologies. During Phase II, vendors will design and develop a prototype of the integrated training system for demonstration to stakeholders.

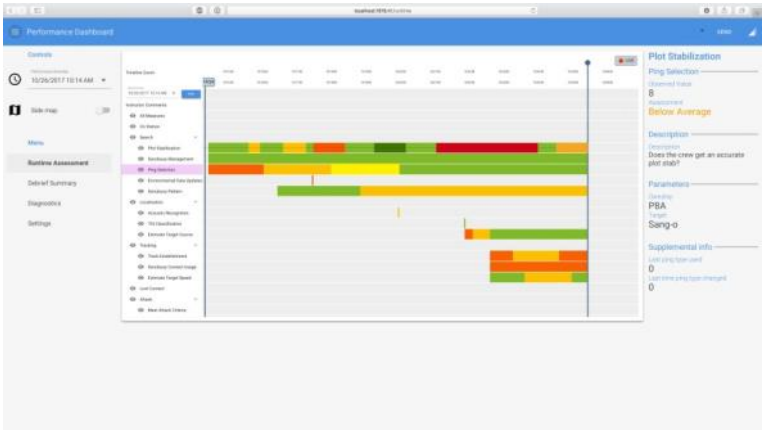
MILESTONES

- Kickoff meeting was held with stakeholders including Naval Air Warfare Center Training Systems Division and PMA-205
- Coordination is underway with multiple user groups to refine design and development of prototypes
- Iterative software development is resulting in prototype system capability that are under evaluation by Navy stakeholders through FY22

POST-MISSION ASSESSMENT FOR TACTICAL TRAINING & TREND ANALYSIS (PMATT-TA): SIMULATION-BASED TRAINING TOOLS

OBJECTIVE

PMATT-TA implements instructional tools for simulation-based training to increase training effectiveness and efficiency automated performance measurement and assessment capabilities that support post-event reporting and trend analysis, facilitating a better understanding of aircrew performance and proficiency.



The PMATT-TA Increment 2 instructor interface provides a timeline display with quick access to automated, system-based performance measurement results

PROJECT DURATION

OCT 2010 - JAN 2023

SPONSORS

PMA-290; PMA-205;
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: TT
Office of Naval Research (ONR); NAVAIR Small Business Technology Transition (STTR)

POINTS OF CONTACT

Beth Atkinson (PI)
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John Hodak (PM)
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DESCRIPTION

PMATT-TA efforts for simulation-based training tools targets research, development, and implementation of automated system-based performance measures, increased automation for post-mission reporting, and technology to support community sustainment and development of performance measures as tactics, techniques, procedures, and mission tasking evolves.

NEED

A Statement of Urgent Need (CPRG, JUN 2010) highlighted the lack of existing Navy products to support force-wide Anti-Submarine Warfare (ASW) training assessment. The call cited the lack of centralized performance data as the key limiting factor that needed to be address with objective, outcome-based performance data to understand aircrew performance based on measures that provide force-wide tactical proficiency and support targeted remediation via training solutions.

BENEFITS

PMATT-TA's simulation-based training tools increases the reliability and standardization in performance feedback provided to aircrew. PMATT-TA will also assist stakeholders in accurately gauging Fleet readiness and competencies in a streamlined and easy-to-use way based on the results of observer and system-based performance measures. The final product seeks to provide a novel technology to view trends in training and performance, ultimately allowing for more informed decision-making and proficiency tracking.

STATUS

The effort received FY20-21 funding from PMA-205 and PMA-290 to facilitate a software build that is compatible with a new software architecture (NIS 1516), implements new performance measures, and delivers a Performance Measure Workbench software capability. The funding also supports iterative usability analyses and research to inform the Concept of Operations (CONOPS) and performance measures pertaining to new combat systems capabilities. Testing is underway to finalize transition of a new build of the performance measurement software within the P-8A simulators.

MILESTONES

- **Manuscripts/Publications:**
  - Atkinson, Tindall, Killilea, Anania. (2018). Advancing performance assessment for aviation training. Proceedings of AHFE.
  - Atkinson, Tindall, Killilea, Tolland, & Dean. (2017). Standardizing human performance measurement for ease of data analytics. Proceedings of the I/ITSEC.
  - Tindall & Atkinson. (2019). Standardizing performance measurement while ensuring psychometric validity. Proceedings of the I/ITSEC.
- **Presentations:** Demonstration exhibit at IITSEC 2017.
- **Workforce Development:** Mentored junior teammates on program management, interaction for transition, usability analyses, and coordination with Fleet customers.
- **Transitions:** Transition of PMATT-TA Performance Dashboard to PMA-290 with APN funding in FY18--FY22.

REMARKABLE DATA SOURCES IMPROVED DEBRIEF AND TREND ANALYSIS ACROSS THE TRAINING PIPELINE

OBJECTIVE

Create a suite of usable, flexible tools that can import, tag, and format data to enable fusion, interpretation, and analysis of needed data for training to include F/A-18 aircraft mission/maintenance data and audio communication.

Google Images of F/A-18 Aircraft, Radio, and Mission Card

PROJECT DURATION
JUN 2020 - JAN 2022

SPONSOR
Office of Naval Research (ONR)
Global TechSolutions

POINTS OF CONTACT
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DESCRIPTION
Development under this effort will include machine learning algorithms to train models to recognize patterns in the data and interpret communication to enable the association of raw, live data (e.g., RM AMU data, SHARP data, NALCOMIS) with other objective data currently being used (e.g., timelines and events) in debrief to better assess training outcomes. Ultimately, we will provide a suite of tools, within Next Generation Threat System Analysis and Reporting Tool (NGTS ART), that will allow the Naval Air Warfare Development Center (NAWDC) and other Fleet users to ingest, tag, interpret and fuse data with contextual information from exercises in a common database for analysis of training to include F/A-18 aircraft mission/maintenance data and audio communication of relevant platform.

NEED
The Integrated Training Facility (NAWDC) Tactical Air Simulator Requirements document (24 May 2016) specifically calls for instrumentation to allow rigorous comparison of simulator performance to performance data from live flight (e.g., F/A-18 data bus recorder) to track performance, refine Tactics, Techniques, Procedures , refine training syllabi and scenarios, and determine the optimum mix of simulator and live events for training. Moreover, the ITF Tactical Air Simulator Requirements document specifically calls for interoperability with the Air Wing Training Facility (AWTF). Therefore, both ITF and AWTF have a need to incorporate live data into the NGTS ART to enhance their debriefing capabilities and this effort seeks to provide a baseline capability through inclusion of aircraft data and audio data.

BENEFITS
NAWDC is developing the capability to collect and analyze detailed data on training evolutions. While the data will be collected, much of it will need new tools to be put in useful form. Thus, this effort seeks to fill this gap by adding voice recognition and the capability to read and format F/A-18 mission data collected through telemetry to the FAM2OUS toolset. This enhanced capability will increase proficiency, readiness, and overall mission performance a need exists to develop a toolset that enables automatic capture and analysis of competency-based, objective performance indices of readiness to improve accuracy of assessment and quality of instruction.

STATUS
Throughout FY21, the team has developed the core architecture to support the Remarkable enhancements to FAM2OUS. These include 1) Voice to Text to Context speech synthesis capability using DeepSpeech for live and simulated radio communications, 2) Link16 real-time event tagging and red threat detect to engage timelines for debrief, 3) The ability to parse and query live mission and maintenance card data. Demonstration of these core capabilities will be held Q1 FY22. Full integrated capability is slated for delivery and demonstration Q2 FY22.

MILESTONES

- Conducted requirements development and feedback sessions with NAWDC end user
- Implemented and tested Link16 real-time events and their ability to populate on the debrief timeline
- Implemented and tested inverse events that should show the life of a red threat throughout the detect to engage timeline
- Enhanced Voice to Text to Context DeepSpeech model to show greater accuracy and train using domain relevant communications
- Implemented architecture for parsing and querying unclassified maintenance card data that is being applied to classified mission data
- Initial demonstration of core capabilities to be held Q1 FY22
- Final integration, test, and demonstration to be held Q2 FY22

RESPOND: MH-60R COMMUNICATIONS TRAINER

OBJECTIVE

Provide a game-based software solution that enables aircrewmen to practice communication procedures in an immersive and relevant environment that can communicate back to the student, as well as provide debrief information.

Scorpions of Helicopter Maritime Strike Squadron (HSM) 49, identifies and tracks surface contacts at a sensor operator console aboard an MH-60R (JUL 2017)

PROJECT DURATION
MAY 2020 - MAY 2022

SPONSOR
Office of the Secretary of Defense (OSD)
U.S. Department of Defense (DoD) Rapid Innovation Fund (RIF)

POINTS OF CONTACT
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DESCRIPTION
Respond is a training system designed to allow aircrewmen to converse with speech-enabled agents and the ability to manipulate relevant displays within the aircraft during mission execution. This system will have multiple impacts on the H-60R community: 1) increase the proficiency and confidence of aircrewmen when speaking on the radios; 2) provide a visual environment for part task training, and 3) leverage external simulation engines to properly model the fidelity of training scenarios as appropriate.

NEED
Aircrewmen are seldom afforded sufficient real world opportunities to communicate during training, reducing their impact to crew performance and increasing the time it takes to reach full proficiency. Pilot training drives nearly all scheduling decisions, and aircrewmen are paired with pilots based on training needs. There are few opportunities to have dedicated flights based on communication-based proficiency, and aircrewmen have limited tools at their disposal to conduct self-training. Generally, two students will practice together, resulting in a low level of standardization, and no quality checks. Content and scenarios largely rely on student imagination and current knowledge. There is a need for greater standardization and a more formalized way for aircrewmen to practice communications, as well as receive feedback regarding their performance on communication metrics.

BENEFITS
Respond will provide a standardized and structured way for aircrewmen to practice various communications, and receive feedback without the need for an instructor. This allows for value-added training without overburdening instructors or requiring classroom-specific time for the addition of communications-based training in the MH-60R aircrewmen course of instruction.

STATUS
In FY21 Q4, efforts focused heavily on expanding the virtual environment for additional mission and scenario needs based on inputs provided by the end user community in FY21 Q3 discussions and feedback. Regular communication has been kept to ensure project is on track regarding end-user expectations, including a working group meeting during FY21 Q4 to discuss project development and priorities, potential alignment with other S&T efforts to increase capability solutions provided at the conclusion of the effort, and to identify future areas for research and development questions that are generalizable to other communities and training initiatives. Work in FY 21 Q4 focused on signing media and art aspects, further improving the back-end engine and capability for debrief functionality, speech recognition developments, and general prototype system performance and capability improvements.

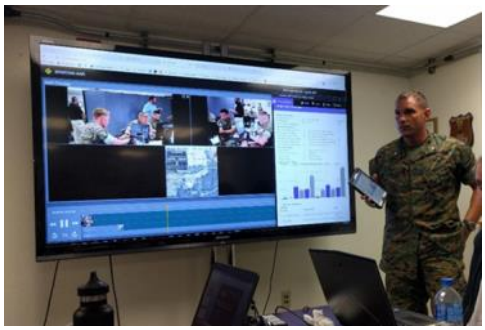
MILESTONES

- Contract award was made to the small business for design and development.
- A kickoff meeting was held with stakeholders at PMA-205, PMA-299, Fleet squadron/wing personnel, and NAWCTSD in JUL 2020; demonstration of rapid prototype that integrated modular capabilities from Small Business Innovation Research efforts was provided with positive feedback from Fleet stakeholders
- Conducted development to support media content and art, advancement of the scenario and virtual environment engine including expansion of the scenario library, refinement of the speech capabilities, and investigation of a modular system solution to support different training requirements by mission set.
- Explore un-facilitated debrief capability solutions to underpin a diagnostic debrief for situations where instructorless practice or remediation training is desired.

STREAMLINED MARINE AFTER-ACTION REVIEW (AAR) TOOL - VISUALIZATION (SMART-VIZ)

OBJECTIVE

Develop an intelligent AAR system that provides the capability to streamline AAR content, allowing for the timely selection and review of specific training events, thereby enhancing post-exercise (live or simulated) learning. The tool will incorporate automated performance assessment, trend analysis, and adaptive training techniques to promote AARs that are more effective and timely. Objective measures of force-on-force skills (to assess outcome effectiveness/performance) will also be developed and validated.



Envisioned SMART-VIZ System

PROJECT DURATION

DEC 2020 - DEC 2024

SPONSORS

Office of Naval Research (ONR)-34

POINTS OF CONTACT

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DESCRIPTION

SMART-Viz is an ONR Science and Technology (S & T) Future Naval Capability (FNC) effort that supports the U.S. Marine Corps Live, Virtual, and Constructive – Training Environment (LVC-TE) initiatives by focusing on Marine Corps ground force-on-force training. This effort will yield an intelligent AAR system that provides the capability to streamline and review select AAR content at specific times, while also using objective assessments, to enhance learning following live and simulated training events. SMART-Viz will also integrate objective performance measurements and assessment algorithms to improve AAR efficacy. This is by allowing the system to (1) target the AAR content to key performance strengths and weaknesses, (2) provide trend analyses, and (3) provide automation to streamline AARs in harsh military training environments.

NEED

Marine Corps force-on-force training exercises—due to their length and complexity—often yield numerous performance data in various, disparate formats (e.g., video, position tracking, and assessments). Although Marines know they must perform a timely review of critical training elements to provide feedback as quickly as possible, the extensive amount of time, labor, and infrastructure AARs require can hinder their timeliness and effectiveness. These situational constraints can cause delayed training feedback that is impractical for reuse in addressing individual learning/ training objectives (i.e., is heavily subjective and unstructured). AAR capabilities are needed that can mitigate these challenges and maximize the value of force-on-force training exercises. This effort seeks to address this need.

BENEFITS

The SMART-Viz tool is expected to have several warfighting payoffs for the Marine Corps. It will provide the operational benefit of improved learning and decision-making by training with the following:

- an automated AAR tool that condenses review data to key elements,
- an immediate sync up of various formats of live and simulated training content,
- the ability to diagnose trainee weaknesses for targeted remediation,
- objective performance metrics for predicting and analyzing performance outcomes, and
- the potential to experiment with the application of Machine Learning (ML) to further streamline the AAR capabilities.

SMART-Viz will also offer deployment of testbed hardware, software, and knowledge products for conducting objective, automated, and streamlined AAR capabilities.

STATUS

In the year since the contract was awarded, the project team defined the behavioral, cognitive, and outcome measures. The measures were iteratively piloted to examine their feasibility for capture and presentation during an AAR. The team also developed the requirements, interfaces, and rapid prototypes for the AAR Field Tools. Recently, live-field training participants gave positive feedback on the SMART-Viz tool after seeing it demonstrated during a Marine Air Ground Task Force Warfighting Exercise (MWX) and during The Basic School (TBS) War field exercises.

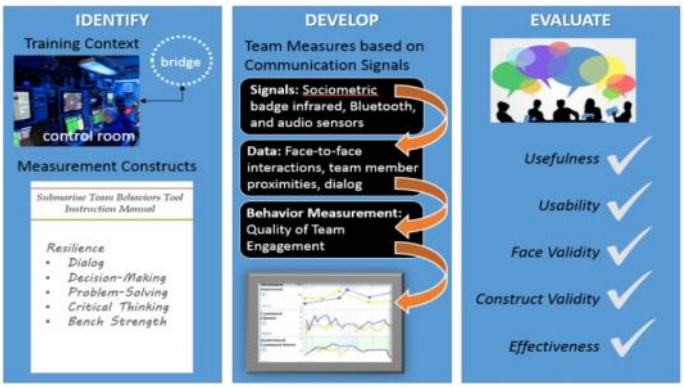
MILESTONES

- OCT 2020 – Contract awarded
- FEB 2021 – MWX AAR observation and information collection
- APR & SEP 2021 – ONR Code 34, Human Performance, Training, & Education Technical Reviews
- JUN & SEP 2021 – Supported TBS War Field Exercises
- OCT-NOV 2021 – MWX pilot testing

TEAM-BASED ADVANCED RESILIENCE ACCELERATOR (TARA) OSD10-CR3

OBJECTIVE

Develop a prototype system called TARA for unobtrusively and objectively measuring teamwork and team resilience behaviors. TARA will also provide descriptive and prescriptive feedback to training instructors to aid them in providing feedback, developing an After Action Review (AAR), and providing recommendations for training scenario adaptation to target areas of weakness within the team.



TARA system concept

PROJECT DURATION

SEP 2017 - SEP 2020

SPONSORS

Naval Aviation Training Systems Program Office, PMA-205

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

POINTS OF CONTACT

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DESCRIPTION

This research and development effort will expand on existing solutions to develop TARA, a team behavior measurement and feedback system that will support coaching, mentoring, training, and self-assessment of team skills. Ultimately, TARA will support performance assessments over time to allow instructors and teams to discover the deep connections that exist between their actions, the task conditions, and outcomes, which will provide them with the foundation they need to act and make intuitive decisions as a resilient team. The TARA system is comprised of Submarine SPOTLITE, for online assessments and immediate performance feedback, and Learning Locker, for storing and tracking team performance over time. Together, these provide benefits for instructor and trainee in terms of understanding a team's strengths and weaknesses, and by using this knowledge to select the optimal training path for the team.

NEED

NAE Science & Technology Objective Alignment: 10. Naval Warfighter Performance (NWP) Capability Gap (10.1 NWP STO-1: Training and Education) Submarine Learning Center expressed an interest in streamlining and enhancing team assessment and team training within scenario simulation trainers and provided a letter of support for this effort. TARA will result in the accelerated development of resilient team skills that are needed for the team to perform effectively and efficiently when on duty. Performance assessment and targeted/adaptive training is needed to accelerate these skills, but instructors are already overworked in these environments. Providing tools to assist the instructor are needed, and TARA meets this need.

BENEFITS

The proposed work will benefit the Submarine Force by providing advanced resilience training to tactical teams at all five levels of training practices: Formal Schools, Formal Qualification, Continuing Training, Inspection and Certifications, and Self-Assessment. These teams will be better equipped to recognize danger and seize opportunity in times of uncertainty, as well as being able to adapt to changing situations. This effort aims to improve the effectiveness and efficiency of training by improving assessment quality and feedback, tailoring training experiences based on past performance, and potentially reducing training time by excluding learned activities.

STATUS

The Contract for this effort was awarded Sept 2017. The first annual technical review of this effort took place Sept 2018. The FY19 effort involved the software development and integration of the tools to include live performance tagging, team member self-assessment, and AAR capabilities. FY20 culminated in the final delivery of the TARA Prototype system to the Integrated Submarine Piloting and Navigation Trainer/ Submarine Bridge Trainer (ISPAN/SBT) at the Submarine Base New London, including final demonstrations to instructors and course leads and technology demonstrations at the Interservice/Industry Training, Simulation, and Education Conference 2019.

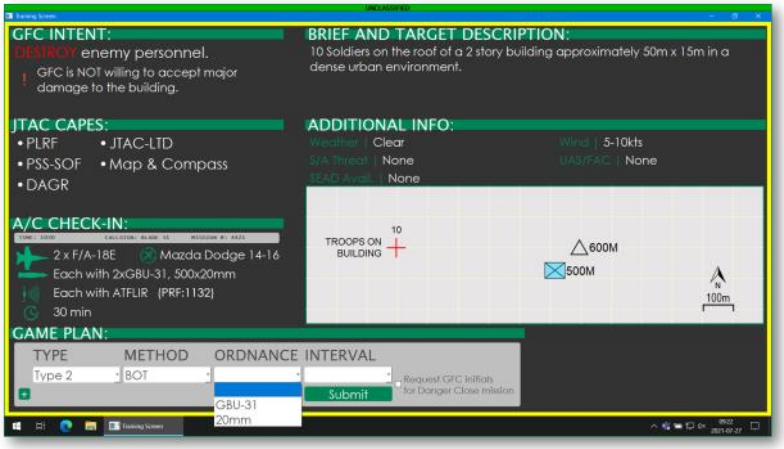
MILESTONES

- **FY19 Deliverables:**
  - ◊ Final Report
- **FY20 Deliverables:**
  - ◊ SEP 20: Final Demonstration of TARA to Submarine Learning Center (SLC)
  - ◊ SEP 20: TARA Software and Hardware prototype to SLC
  - ◊ SEP 20: Final Technical Report

TECHNOLOGY TRANSITION OF THE ADAPTIVE TRAINER FOR TERMINAL ATTACK CONTROLLERS (ATTAC) (TT-21-005)

OBJECTIVE

The goal of this effort is to transition ATTAC, a successful proof-of-concept adaptive training (AT) system, to a training product ready for transition. ATTAC is a scenario-based adaptive trainer that focuses on game plan development, a critical decision-making task in Close Air Support (CAS) carried out by Joint Terminal Attack Controllers (JTAC).



Screenshot of an ATTAC scenario

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: Tech Transition

POINTS OF CONTACT

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DESCRIPTION
Initially developed for an Office of Naval Research effort as a proof-of-concept, ATTAC was designed using science of learning principles and provides the Fleet reps and sets by utilizing self-paced scenario vignettes, assessing the decisions of the trainee, providing tailored feedback, and adapting the difficulty of scenarios based on performance. In an initial evaluation of the system, ATTAC improved students' game plan decision-making performance by over 20% after only 35 minutes of training. Based on significant interest from stakeholders to incorporate ATTAC into their curricula, this project will transition ATTAC from a research testbed to mature, fieldable training product.

NEED
This effort addresses the USN and USMC's needs for flexible, learner-centric training to improve assessment of CAS decision-making skills, enhance performance, and increase mission readiness as outlined in the 2018 S&T Strategic Plan Training and Education STOs 1: Learning and performance assessment), 2: Experiential learning technologies and methodologies, and 3: Warrior decision-making. Additionally, the skillset held by JTACs has been flagged as integral by the Marine Corps' future force designs, as outlined in the Marine Corps Aviation Plan.

BENEFITS
ATTAC offers the ability to provide training for basic CAS skills that is tailored to the needs of individual students. Therefore, when students are in the classroom, valuable time is not spent with instructors going over the basics, but rather more time is spent discussing the more nuanced parts of the task that are harder to capture with computer-based training approaches.

STATUS
In FY21, we began generating requirements for the new version of ATTAC. So far, we have created and implemented new GUI designs, integrated assessment/feedback database queries, reformatted old scenarios to be compatible with new architecture, included scenario visualizations, and implemented a fully capable data dashboard for students and instructors. In FY22, we will ensure proper functioning of the trainer and begin generating requirements from transition customers. Additionally, we will conduct end-user evaluations on the new version of ATTAC to ensure the new tools are useable and provide training value.

MILESTONES

FY21:
- Held initial discussions with potential transition partners
- Created new scenario interface and data dashboards
- Ported testbed version of ATTAC into new architecture
- Created functional beta version of ATTAC

TRAINING DESIGN FOR INTUITIVE EXTENDED REALITY (XR) INTERACTIONS (BAR-21-027)

OBJECTIVE

Taking a user-centered approach, this effort explores methods to redesign user interactions in XR to enhance the user's experience by: 1) establishing the most intuitive methods of interactions for commonly performed tasks and 2) testing different methods of presenting information in an XR-based training system, with the goals to reduce users' cognitive load and improve human performance.

CDR Douglas Kramer training in VISIT™ VR. Photo Credit: Roy Holt, TechRAT

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR

POINTS OF CONTACT

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DESCRIPTION

Many of the problems with today's extended reality (XR) experiences, which include augmented reality (AR), virtual reality (VR), and mixed reality (MR), arise from a poor understanding of how people most intuitively interact with virtual interfaces. Rather than innovating, these misguided designs have relied on forcing artifacts of 2D interaction into XR, leading to unintuitive controls, user frustration, higher cognitive load, and reduced performance/learning outcomes. This effort will explore novel types of XR interaction with the goal of improving the user experience.

The effort includes two human performance research experiments. In the first experiment, we will explore commonly performed tasks in an XR training environment to determine which forms of input (e.g., gesture-based input, gaze tracking, laser pointer) are most effective for said tasks. In the second experiment, we will examine different methods of presenting information in and their impacts on learning outcomes.

NEED

The Navy is investing heavily in XR, and development teams have an immediate need for evidence-based guidelines for XR input and output design. The time to do this research is now, before program offices deploy XR applications on a large scale. This work is timely because it has the potential to prevent costly redesign of difficult interfaces and to prevent the Navy from investing in ineffective training products.

BENEFITS

The results of these experiments will lead to evidence-based guidelines for building more immersive XR training experiences that will benefit the Navy training community broadly. When we build more intuitive, XR-based trainers, users will spend less time learning how to interact with the simulation and more time in training.

STATUS

For FY21, the virtual reality testbed was complete with five different interaction methods for experiment 1. Experiment 1 complete and data analysis has begun. The plan for FY22 will be to develop and conduct study 2, analyze the results and write results for publication.

MILESTONES

- Develop experimental plan for Experiment 1, focused on effective inputs to an XR system
- Submit IRB protocol
- Develop testbed with different input methods to perform common tasks in XR training environments
- Conduct Experiment 1
- Analyze and write up results.
- Conduct Experiment 2
- Analyze and write up results for publication

TRAINING SIMULATION INTELLIGENT SCENARIO GENERATION TOOLS (N02-184)

OBJECTIVE

Develop an anytime-anywhere training tool designed to rapidly create, script, and grade training events and scenarios. Automated performance measurement and after-action review (AAR) reduces Instructor workload, capable of being used in a stand-alone or distributed team training mode.

Training System Demonstration and Testing with End Users

PROJECT DURATION
MAR 2020 - MAR 2024

SPONSOR
NAVAIR Small Business Innovation Research Program

POINTS OF CONTACT
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DESCRIPTION
The technology under development provides a training environment that allows instructors to create, execute, grade, and provide after action reporting and debrief. Highlights include the ability to create training roles and teams, scripted and custom scenario inject content, training event playback, tagging inject elements with course and training objectives, and instructor-in-the-loop student grading. The training jacket capability allows for performance assessment and grade-based reach back at the student and class levels. Training content information is structured to accommodate future development activities that will enable automated training adaptations for improved and tailored grading and training content analysis, resulting in an adaptive training capability at the student, class, and instructor levels.

NEED
With an increased reliance on Naval Intelligence Surveillance and Reconnaissance (ISR) assets for mission support and Intel dissemination, ISR training has become critical to mission success. To support training needs, the Maritime ISR (MISR) requires an agile web-based adaptive training that could rapidly adapt to changing weapon school requirements and teaching situations.

BENEFITS
Development of a distributed and standalone training solution provides flexibility to meeting a variety of training needs and environments. Scenario scripting provides the ability to maintain system utility as tactics and procedures evolve over time.

STATUS
Current training prototype is at a TRL 5 and was used at part of Resolute Hunter Summer 2020. As most Navy weapon schools were forced to cancel or postpone due to the pandemic, prototype technology was used in a distributed manner for MISR's final exercise and practical, allowing the weapons school to remain open to graduate their class as scheduled. Efforts are underway to level set class participants prior to the start of a weapons school class as participants typically come from a variety of Mission Design Series (MDS). Iterative stress tests continue with end users to refine technology. Investigating cloud-based architecture solution for future transition and exploring cybersecurity approval process for seek appropriate certifications.

MILESTONES

- Kickoff meeting was held with stakeholders including Naval Aviation Warfare Development Command including members of the Maritime ISR Weapons School Community, Naval Air Warfare Center Training Systems Division, and PMA-205
- Technology design and development has resulted in a TRL-5 prototype, and due to challenges associated with COVID-19 and in-person training, the end user community elected to leverage the prototype in their final exercise Resolute Hunter to ensure remote training could continue to ensure the Fleet met required proficiency
- FY21: Continued iterative stress testing that includes end user evaluations of modifications and new system capabilities to inform agile development toward final prototype (Sep 21)
- FY22: Complete final TRL level 6 training tool prototype to rapidly create, script, and grade training events and scenarios in stand-alone or distributed team training Mode (Mar 22)
- Approved for Phase II.5 effort, with Technology Transition Agreement under development

TRAINING OPERATIONAL PERFORMANCE VIA MEASURE AUTOMATION AND SCENARIO GENERATION TECHNOLOGY (TOPMAST) (N18A-T003)

OBJECTIVE

Design and develop a software technology that leverages data science and advanced computational analyses of tactical data sources to improve training scenarios and assessments and make training more adaptive, efficient, and effective.

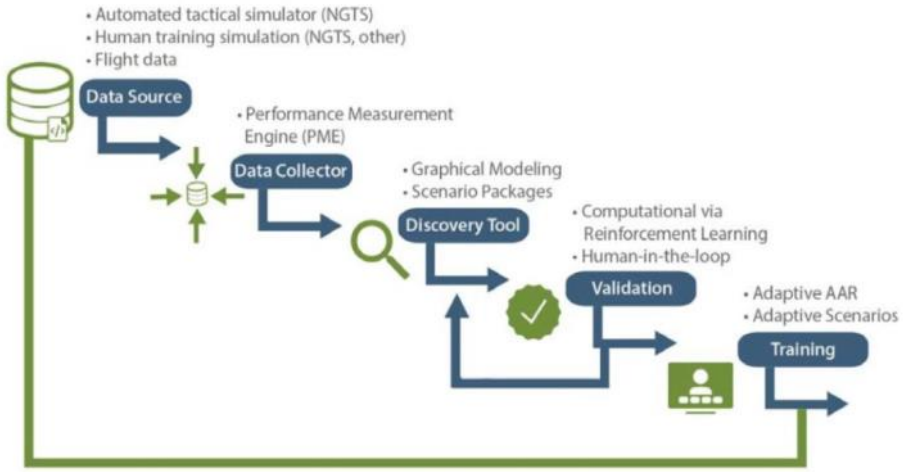

Figure 1. System data flow diagram of TOPMAST.

PROJECT DURATION

SEP 2018 - JUN 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Technology Transition (STTR)

POINTS OF CONTACT

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DESCRIPTION

As the complexity of Tactics, Techniques, and Procedures (TTP) increase, testing in part via computational simulation and optimization is necessary. Such analyses systematically vary tactical applications of the warfare capability to a variety of threat scenarios, simulate and score each encounter, and generate a ranked list of the most successful tactics per threat. The scenarios, measures, and knowledge generated in this type of work are rich and voluminous, providing opportunities to leverage data science. This effort seeks to deliver a software technology solution capable of re-using analytic data outputs for populating training content.

NEED

Emerging warfare capabilities offer many new tactical options to commanders. However, this also increases the demands on decision-makers during operations. The dynamic and complex nature of integrated warfare results in training challenges to prepare for those engagements. To address this need, this effort seeks: 1) the capability to generate scenario libraries, and 2) the ability to improve integrated assessments of human tactical and decision-making skills to make training more efficient and effective.

BENEFITS

Navy leadership has called for technologies that support analytics of big data sets such as avionics and human performance; however, as new systems or technologies are introduced and/or new tactics emerge to maintain superiority, existing training scenarios can quickly become obsolete. Advance statistical or novel modeling techniques are sought to address the unique challenge of ensuring training scenarios are current.

STATUS

Phase II Option period awarded (OCTFY22).

MILESTONES

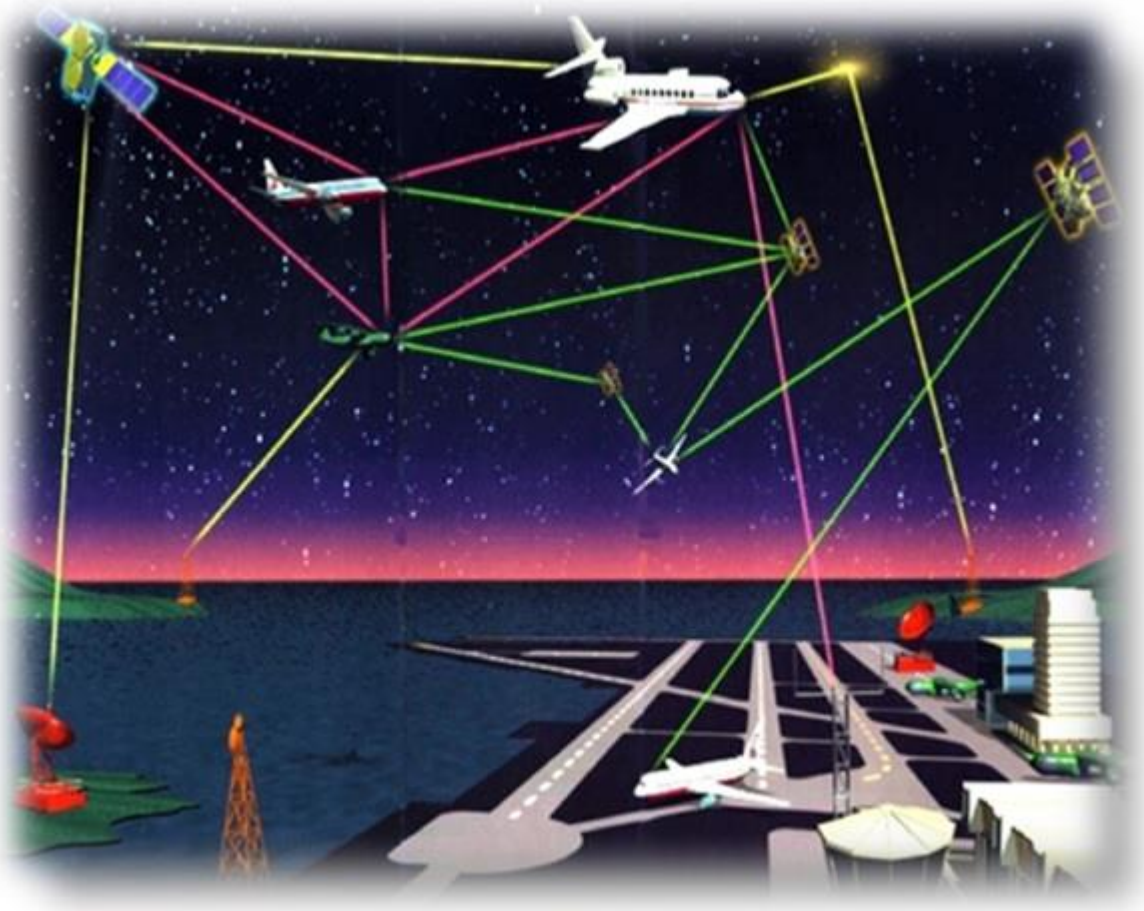
- **Phase I:**
  - Kickoff meetings were held with each of the three Phase I contractors
  - Contractors status was monitored via bi-monthly progress reports and periodic status updates
  - Closeout briefs were held with each of the contractors to discuss Phase I progress and Phase II plans
- **Phase II:**
  - Kickoffs held in Q1 FY20
  - Phase II base period evaluations performed JUL 2020
  - Phase II base awarded to a single contractor SEP 2020
  - Phase II Option awarded OCT 2021

CORE CAPABILITY 3:
ADVANCED TRAINING SYSTEMS TECHNOLOGY

Training systems, such as LVC simulations, provide an appropriate mix of environments where learners can interact in real time with each other using networked devices. Technology can augment warfighter preparedness by providing training opportunities that might not be available due to factors such as cost, safety, and resource availability. Training technology includes the ability to provide realistic rendering and modeling, multisensory input/output devices (e.g., visual/audio/haptic displays, speech recognition, and flight control sticks), and system interconnectivity, such as Web servers, networking bandwidth, and processing speed.

The following Technology areas comprise this Core Capability:

- High-Fidelity Training Environments
- Simulation Interoperability and Distributed LVC Technology



EMPACT IMMERSIVE TRAINING PLATFORM

OBJECTIVE

Development of a high-fidelity, fully interactive virtual T-6B airframe for advanced switchology training which would allow for the creation and storage of new training content (e.g., normal and emergency procedures) that can be accessed remotely via various portable devices.

PROJECT DURATION

APR 2021 - JUN 2022

SPONSOR

Naval Air Systems Command (NAVAIR) Small Business Technology Transition (STTR) & Naval Aviation Training Systems and Ranges Program Office, PMA-205

POINTS OF CONTACT

LT. Michael W. Natali, MSC, USN, Ph.D. (TPOC)
Gabriella Severe-Valsaint (ATPOC)
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DESCRIPTION

Chief of Naval Air Training (CNATRA) will work alongside HTX Labs to provide data for the HTX Labs EMPACT system to tailor the platform to include an interactive 3D model of the T-6B airframe. The EMPACT platform will also enable content creation and storage for remote access in support of various flight operations such as normal and emergency procedures. The system will allow students to view content via videos, practice procedures in the 3D model, and assess performance during the execution of procedures. EMPACT allows students to practice relevant procedures and checklists that may otherwise be too costly or difficult to train in the aircraft.

NEED

Naval Aviation Simulation Master Plan IV Priority 5: refine strategy to "provide a basis of understanding the potential for leveraging technology to solve training challenges."

PMA-205 Strategic Initiative: Investigate the utility of Virtual and Augmented Reality.

BENEFITS

The completion of this effort will provide instructors with a virtual environment in which training content can be created, stored, and accessed by student aviators remotely, earlier on in training. This system will help students execute emergency procedures that are not typically practiced because of the potential for bodily harm and/or damage to aircraft.

STATUS

In FY21, a kickoff meeting was conducted to discuss scheduling and align resources. EMPACT software was deployed for Navy use and existing training content was uploaded for immediate use. Manuals and data from experts were leveraged to build out the T-6B airframe. The development of normal and emergency procedures began and upgrades to performance metrics are being tailored for instructor use.

MILESTONES

- Q3 FY21: Conduct kickoff meeting to set initial planning strategy
- Q3 FY21: Deploy the EMPACT software platform to support digital training courseware
- Q3 - Q4 FY21: Develop an interactive 3D virtual environment with a T-6B airframe
- Q4 FY21: Develop normal and emergency procedures
- Q1 FY22: Delivery of finalized procedures, acceptance testing, and final report
- Q2 - Q3 FY22: Develop additional training content
- Q3 FY22: Deliver updated final report to include summation of additional development

VIRTUAL ENVIRONMENT CORRELATION THRESHOLDS

OBJECTIVE

Reuse, develop, prototype and integrate visual correlation metrics to predict visual database correlation on distributed network exercises and provide corrective attributes to trainer procurements.

PROJECT DURATION
OCT 2021 - SEPT 2023

SPONSOR
NISE TT

POINTS OF CONTACT
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DESCRIPTION
This effort seeks to link visual correlation metrics to distributed network visual anomalies. The hypothesis is that a set of visual database metrics and thresholds exist that can avoid visual anomalies in distributed training. This project in collaboration with SBIR topic N141-006 seeks to identify the minimum set of visual database parameters that control visual database correlation. SBIR topic N141-006 will develop the validation tools and metrics necessary for collection and analysis. Visual database runtime data will be collected from selected heterogeneous USMC Aviation Distributed Virtual Training Environment (ADVTE) Aviation Training Systems (ATS). The data will include visual database data such as terrain elevation and feature content. The data will be used to extract correlation threshold and develop a model that can predict the levels of correlation necessary to avoid visual anomalies in virtual exercises.

NEED
Differences in visual databases (i.e. visual database correlation) have been linked to visual anomalies that negatively impact training and fleet readiness resulting in training and readiness (T&R) qualifications not being met in the trainer. The gap addressed by this NISE project is the level of visual database content correlation, or degree of similarity in visual scene content, that is needed to avoid visual anomalies in distributed mission training.

BENEFITS
Correlated heterogeneous visual databases will reduce visual anomalies from ADVTE during distributed mission training (DMT). The end goal is to enable more training in simulators than live-fly, therefore reducing operational costs and risk. No Navy/USMC tools exist that can measure correlation between visual databases used within the ADVTE program. Differences in visual databases (i.e. visual database correlation) have been linked to visual anomalies that negatively impact training and fleet readiness when T&R qualifications cannot be met in the trainer. Determination of significant differences prior to a DMT will be used to select areas that are well correlated and minimize visual anomalies. Using acceptable correlation thresholds, correlated visual databases can be developed to minimize visual anomalies during DMT and enable the Fleet's ability to meet additional T&R qualifications in ATS, saving valuable live-fly training costs.

STATUS
Project kickoff Oct 2021.

MILESTONES

- Kickoff Oct 2021
- SBIR Phase II.5 topic N141-006
  - Topic proposal evaluation Q1 FY22
  - Contract award Q2 FY22
- Validate SW tool development Q3 FY22
- TDBCAT (Validate SW + HW) development Q3 FY22
- ADVTE Next IG Hook up testing Q2 FY23
- ADVTE Next Visual Database Data Gathering Q3 FY23
- Data Analysis Q4 FY23

MASK-ON BREATHING DEVICE (ONR TECHSOLUTIONS TS-872)

OBJECTIVE

Enhance Mask-On Breathing Device training capabilities through delivery of surplus airflow and reduction of airflow, to reproduce situations that address a range of root causes that result in difficulty in inhalation and exhalation. Research individual differences in experiences to training scenarios to inform instructional guidance and debriefing solutions.

Demonstration of prototype mask on breathing device at ASTC Pensacola, FL in February 2020. Photo credit NMOTC PAO

PROJECT DURATION
MAY 2021 - JUN 2022

SPONSOR
ONR TechSolutions

POINTS OF CONTACT
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DESCRIPTION
This effort includes the conduct of research and development efforts necessary for validating the fidelity, safety and concept of operations of the pressure on demand training device developed for transition to PMA-205 and the Naval Aviation Survival Training Program. In addition to the required research, we intend to conduct separate independent tests and evaluations to document the performance parameters and benefits of the novel technology for existing and potential acquisition communities. Specific tasks include: research and analysis of logistic requirements for training technology; conduct Human Factors Evaluation of the instructor console; conduct human testing with a military aviator population; and validation of training system. Expansion efforts will seek to increase system capability to achieve a more broad range of dynamic breathing threat awareness training to meet emerging requirements as a result of physiological episode investigations.

NEED
This effort seeks to address technology needs that have emerged as requirements due to changes to training requirements (CNAF M-3710.7) for Dynamic Breathing Threat Training. The solution under development provides exposure to multiple physiological responses regardless of root cause to increase awareness and recognition for mitigation that will increase aviator safety and survivability.

BENEFITS
The acknowledged success of hypoxia training makes it paramount that the Navy ensures these capabilities remain available. In addition to addressing hypoxia training needs, this effort seeks to provide a means for addressing the larger Navy physiological episodes training needs through development of solutions for a broader range of dynamic breathing threat scenarios. This effort will advance the lab's understanding of these various physiological impacts and identify strategies to support new training solutions. Through usability analyses, researchers will document ways to increase the ease of use of the instructional capability. Further, this effort will provide the means to thoroughly investigate a novel technology to determine the effectiveness and efficiency of the devices to deliver higher fidelity training opportunities.

STATUS
Development of enhancements to the architecture and firmware of the Flight Breathing Awareness Trainer (FBAT) for scenario development & real-time instructor modifications of breathing air flow rate or pressure. Investigate debrief capabilities in FBAT and Aviation Reconfigurable Cockpit for Hypoxia & Hazard Exposure and Recognition (ARCH2ER) based on research of biometric capabilities that support instructional strategies.

MILESTONES

- Developed system firmware enhancements to allow for control of pressure and flow rate to facilitate training profiles that address restricted inhalation and restricted exhalation scenarios (SEP-OCT 2021)
- IRB for dynamic breathing threat training profile evaluation in process (NOV-DEC 2021)
- Data collection planning and research testbed refinement in process (NOV-DEC 2021)
- Data collection planned for JAN-APR 2022

EMULATE, APPLY, EVALUATE, AND EXPLAIN (EA2E): DATA TRANSPORT METHODS IN SIMULATION

OBJECTIVE

The objective is to measure, assess, and evaluate the tolerance and resilience of distributed Live, Virtual, Constructive (LVC) air-to-air mission oriented data while applying degradation parameters of values such as latency, jitter, and packet loss. Through intensive analysis/evaluation, a verified and validated long haul network experimental simulation model, an interaction-timing-reaction matrix, and a findings/recommendation report will be produced.

High in the skies over the Joint Pacific Alaska Range Complex multiple contrails circling each other in close proximity.

PROJECT DURATION

OCT 2021 - SEPT 2023

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: TT

POINTS OF CONTACT

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DESCRIPTION

The EA2E effort is focused on (a) accelerating RDT&E of parallel solutions targeting LVC capability improvements; (b) furthering DoD transitions to augmented simulation that aid in predictive modeling of network configurations for events such as large-scale distributed training and LVC exercises; (c) improving time-in-training benefits associated with LVC training; and (d) decreasing network costs. Through development of a verified and validated long haul network experimental model that is flexible and easily customizable, an interaction-timing-reaction matrix will inform the prioritization of "needed now" training data, and methods, measures, and metrics often overlooked in this domain.

NEED

Within distributed Live, Virtual, Constructive training environments, degradation of network performance impairs Fleet learning, training, and operational readiness levels. Degradation parameters such as latency, jitter, and packet loss interferes with the transmission and receipt of critical training data. Often times, such data is assigned a lower priority amidst transmit/receipt of other data types. EA2E seeks to uncover richer ways to look at and understand the data to ensure proper prioritization.

BENEFITS

Analysis outputs will benefit and align with multiple efforts and transitions focused on reducing latency, network jitter, and packet loss from a technical engineering and human performance stance. Moreover, EA2E benefits have the potential to reduce risk to ONR programs, speed up data and voice compression and prioritization research and algorithm development, as well as, support transition of high quality LVC capabilities to the Fleet as a result of dispersing and integrating benefits across internal and external Navy and Marine Corps LVC initiatives.

STATUS

This is an FY22 new start. The EA2E Project Plan is being executed. The long haul network experimental model design is underway.

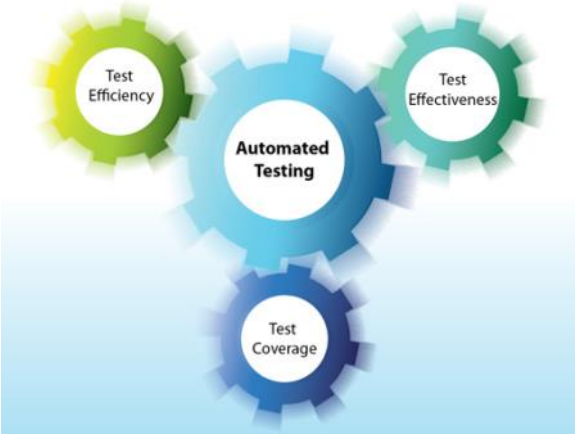
MILESTONES

- Year 1: Draft model design/development, verification/validation (V&V; Phase I), experimentation & analysis (Phase I-II), project performance reporting
- Year 2: Model refinement/extension, verification/validation (Y&Y; Phase II), experimentation & analysis (Phase III – IV), S&T product developments/findings/recommendations documentation, project performance reporting

AUTOMATED SOFTWARE TESTING CAPABILITY (WFD-SG-20-022)

OBJECTIVE

Analyze, design, and implement an automated and extensible software testing capability for the IDEA Lab, and deploy it in the development and maintenance of the Federation Agreements Compliance Test Tool (FACTT) Suite software as a use case.



Automated Testing

PROJECT DURATION

OCT 2019 - SEP 2020

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD: SG

POINTS OF CONTACT

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DESCRIPTION

The proposed effort will analyze, design, and implement an automated and extensible software testing capability for the IDEA Lab, and then deploy it in the development and maintenance of the Federation Agreements Compliance Test Tool (FACTT) Suite software as a use case. The choice of FACTT Suite is fitting because it is a critical and contractually required software product for assessing NASMP/NIS standards' compliance for the Fleet Synthetic Training - Aviation (FST-A) simulations and it has become an increasingly complex software system, which has hampered its development and testing efforts and caused delays in delivering critical capability to the users.

NEED

This capability is urgently needed to address the current inefficiencies in software development and testing processes in the NAWCTSD-IDEA Lab which has contributed to delays in software product deliveries and at a higher cost. Particularly, FACTT Suite will immediately benefit from it as an early technology adopter.

BENEFITS

The proposed capability will enable software developers to uncover implementation issues sooner while requiring less manual labor. This capability will enhance the IDEA Lab software development process by shortening the software development and testing cycles and yielding more robust software products in a timely manner.

STATUS

Completed implementation of automated software build and testing infrastructure and delivered to the NAWCTSD IDEA Lab for use by the resident software development teams.

MILESTONES

- Research on automated testing technology and strategies complete (Oct 19)
- System requirement for automated build and testing infrastructure complete (Nov 19)
- System design for automated build and testing infrastructure complete (May 19)
- Prototype of automated build and testing infrastructure complete (Jul 19)
- Stand up the automated build and testing infrastructure in the IDEA Lab complete (Sep 21)

DESKTOP TACTICS TRAINER FOR MARITIME PATROL AIRCRAFT (N202-111)

OBJECTIVE

Develop a desktop tactics trainer with a low-cost, computer-based, simulated environment where trainees can practice tactics learned in advance of simulator events, and flight events.

A P-8A Poseidon multi-mission maritime patrol and reconnaissance aircraft assigned to Patrol Squadron (VP) 4 (MAR 2020)

PROJECT DURATION
OCT 2020 - JAN 2024

SPONSOR
NAVAIR Small Business Innovation Research Program

POINTS OF CONTACT
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DESCRIPTION
Fleet Naval Flight Officers (NFOs) in the Maritime Patrol community are trained to: 1) conduct anti-submarine warfare first, 2) conduct intelligence, surveillance, and reconnaissance always, and 3) conduct anti-surface warfare, if needed. They use the multi-mission aircraft platform, the P-8A, to accomplish these missions. The aircrew consist of multiple personnel (both enlisted and officers) operating a multitude of sensors. Through combining their training with the advanced and complex capabilities of the aircraft, they are tasked primarily with finding and tracking submarines and ships in the world's oceans. Trainees need a practical way to apply classroom training between scheduled part-task trainers (PTT) or weapon tactics trainer (WTT) simulator events.

NEED
Currently, fleet students (upgraders) do not have a tool that allows them to try-out and practice learned tactics in a simulated environment without scheduling highly limited and valuable time in a multimillion-dollar simulator. The job is difficult, and the crew need to be proficient in their roles making the most use of the maritime platform. Real ships and submarines are typically not available to train maritime aircrews. Additionally, when given real surface and subsurface platforms to train with, they are U.S. or allied friendly forces. Training against real-world adversaries provides a higher fidelity of training.

BENEFITS
A computer-based tactics trainer is a cost-efficient way to provide hands-on tactics training on demand to NFOs. By providing a "learn on your own" simulator tool, students can increase their knowledgebase before an event, and decrease the likelihood of event failure, maximizing the value of expensive crew simulator events, both in effectiveness and efficiency. The ultimate result is enabling trainees to be more qualified at the end of training, while increasing their readiness and ability to perform the tasks in the operational environment.

STATUS
One contractor from Phase 1 was invited to submit a full Phase 2 proposal to be awarded in early 2022. Work will focus on transitioning the Phase 1 proof of concept, to a fully developed prototype in Phase 2. The team will also look to incorporate high-fidelity real-world data within the trainer during Phase 2.

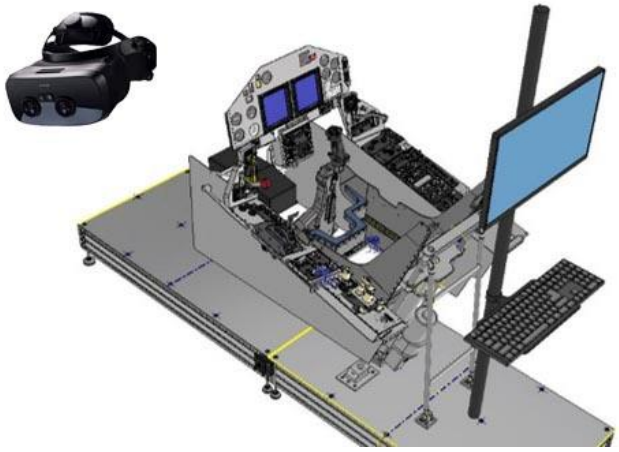
MILESTONES

- Phase 1 kickoffs held in late 2020
- Phase 1 closeouts will take place in January 2022
- Phase 2 will be awarded in early 2022
- Early prototype demonstrated at NAS Jacksonville for Fleet stakeholders from the current Weapons Tactics Instructor class (September 2021)

EXTENDED REALITY (XR) FLIGHT TRAINING RESEARCH SYSTEM INTEGRATION LABORATORY CAPABILITY (RR-21-006)

OBJECTIVE

Establish a dedicated and sustainable System Integration Lab (SIL) capability at NAWCTSD focused on Extended Reality (XR) technologies in support of student aviator training.



XRSIL Testbed

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSORED
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: R&R

POINTS OF CONTACT
Rocco Portoghese (PI)
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DESCRIPTION
This effort will establish a dedicated Extended Reality (XR) flight training System Integration Laboratory (SIL) at NAWCTSD. The effort will design and fabricate a reconfigurable single-seat cockpit surround with flight controls and procure a mixed reality (MR) head mounted display system and simulation environment in order to create a flexible XR integration and experimentation capability. The end result of this project will be a government-designed and owned flight trainer targeting the T-45 platform. The overarching objective of the XRSIL is to be a flexible and reconfigurable testbed in order to support other training platform configurations and future experiments, tests or development efforts.

NEED
The Chief of Naval Air Training (CNATRA) has established the Naval Aviation Training Next (NATN) initiative to produce better prepared aviators via the creative use of new and emerging technologies. NATN has a particular focus on the promise of XR approaches. CNATRA has determined that executing an effective undergraduate pilot syllabus that equips students with Fleet Replacement Squadron entry-level skills will require further improvements and expansion of current virtual reality capabilities, including continuously evaluating and rapidly implementing evolving XR technologies. Timely and cost-effective technology investigations require the establishment of a dedicated SIL and experimentation capability focused on rapidly assessing and demonstrating the utility of emerging XR technologies.

BENEFITS
Emerging technologies, such as XR, can provide pilots more frequent training opportunities at a lower cost than traditional Operational Flight Trainers. The organic hands-on test and development capability provided by the XRSIL will speed the adoption of these training technologies and lower developmental cost and risk.

STATUS
Active development and testing is underway.

MILESTONES

- Stood up representative virtual environment: flight simulator (Lockheed Prepar3d), aero model (Milviz T-45) and mixed-reality headset (Varjo XR-3) - May 21
- Designed and built trainer base and structure - May 21
- Developed and fabricated USB plug-and-play board set to allow rapid and flexible integration of flight controls – Jun 21
- Developed and fabricated simulated T-45 power control level, control stick - Aug 21
- Demonstrated basic carrier operations capability - Aug 21
- Demonstrated trainer initial capability to CNATRA - Sep 21
- Add additional simulated aircraft controls and capabilities, complete cockpit surround and demonstrate to CNATRA personnel - throughout FY22

EVALUATION OF EXTENDED REALITY (XR) HEAD-MOUNTED DISPLAY (HMD) TECHNOLOGY AS A REPLACEMENT FOR OPERATION FLIGHT TRAINING (OFT) DISPLAYS

OBJECTIVE

Develop a T-45 Mixed Reality (MR) flight testbed that leverages a fabricated cockpit and an MR HMD to provide an ability to interact with the cockpit and provide 360 degree visuals. Evaluate the benefits and training impact of the MR flight training on student pilots.

NAS Kingsville T-45C OFT + Mixed Reality Visual System

PROJECT DURATION

OCT 2020 – OCT 2022

SPONSOR

Office of Secretary of Defense (OSD)
Foreign Comparative Testing (FCT)

POINTS OF CONTACT

LT Michael Natali, Ph.D. (TPOC)
Rocco Portoghese (Structure)
Benito Graniela (XR)
Gabriella Severe-Valsaint (Evaluation)
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DESCRIPTION

With the increased interest in utilizing Extended Reality (XR) Head Mounted Displays (HMDs) in aviation training, the Chief Naval Air Training (CNATRA) has asked Naval Air Warfare Center Training Systems Division (NAWCTSD) to develop a Mixed Reality (MR) flight trainer testbed. The Foreign Comparative Testing (FCT) T-45 Mixed Reality (MR) flight trainer development and evaluation focuses on using promising MR COTS HMDs within a representative setting (basic flight training aboard CNATRA) to characterize performance, identify limitations, refine MR requirements and provide feedback to industry.

NEED

The CNATRA program is currently exploring the potential use of XR Part Task Trainers (PTTs) to supplement their existing curriculum. The lower cost and smaller footprint of XR PTTs compared to Operational Flight Trainers (OFTs) will make more training devices and simulator time available to student aviators, improving the quality and speed of training. Exploration and refinement of XR technology now will inform and support those future acquisitions and improve the delivered devices.

BENEFITS

Currently, the Navy, Army and Air Force utilize a combination of classroom lecture, static training, OFTs and live aircraft flight to train aviators. The urgency to augment the aviation training pipeline with XR technology, as identified in the Navy's "Naval Aviation Training Next", the Air Force's "Pilot Training Next" and the Army's "Aviation Training Next" programs, has highlighted the fact that XR technology has the potential to increase student access to training and reduce instructor workload, at a fraction of the cost comparted to larger-scale OFTs or live aircraft. This effort directly supports the goals of the "Training Next" programs.

STATUS

Active development and testing is underway throughout FY22.

MILESTONES

- Defined testbed requirements and target flight training scenarios – Feb 21
- Stood up representative virtual environment: flight simulator (Lockheed Prepar3d), aero model (Milviz T-45) and mixed-reality headset (Varjo XR-3) - May 21
- Developed two carrier operation scenarios – Jun 21
- Developed and fabricated T-45 flight trainer testbed – Aug 21
- Demonstrated basic carrier operations capability to CNATRA – Sep 21
- Continue development of testbed in support of CNATRA's training goals – Q1, Q2 FY22
- Perform Training Effectiveness Evaluation – Q2, Q3 FY22
- Complete Training Effectiveness Technical Report – Q4 FY22

FLIGHT DECK CREW REFRESHER TRAINING EXPANSION PACKS (TEP)

OBJECTIVE

The objective of this effort is to create an expandable framework of game-engine-based, immersive 3D Flight Deck Crew Refresher Training Expansion Packs (TEP) for use by trainees in Fleet Concentration Areas (FCA). The TEPs shall allow for individual, team, or multi-team training events, and shall utilize appropriate combinations of state of the industry immersive technologies, including virtual reality.

Screenshot of actual 3D flight deck and aircraft models used for the effort.

PROJECT DURATION
JUL 2017 - SEPT 2021

FUNDING SPONSOR
Office of Naval Research Global (ONRG), TechSolution, PMA-205, PMS-378

POINT OF CONTACT
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DESCRIPTION

NAWCTSD has created an expandable system baseline architecture and built three flight deck teams: 1) Primary Flight Control (Pri-Fly) TEP, 2) Landing Signal Officer (LSO) TEP, and 3) Catapult Launch TEP. The development process has included over 55 Fleet Subject Matter Experts (SME) from five carrier hulls and two schoolhouses. Work is continuing by adding faults, scenarios, and passes to the existing teams, expanding teams, and delivering to Norfolk in the C-ARTS system via a Cooperative Research and Development Agreement (CRADA) with Cape-Henry Associates and PMS-378.

NEED

Flight Deck Crew readiness, refresher, and certification training opportunities are limited. The training pipeline and available technology for flight deck crew initial training is often limited or outdated, and crew members are often sent to other underway carriers for refresher training and readiness sustainment. This is costly to the ship and logistically challenging, and results in crew members not training with their actual team members. New Ford Class carrier crew members are not training on the correct Aircraft Launch and Recovery Equipment (ALRE) gear.

BENEFITS

- Increase readiness, refresher, and certification training opportunities for aircraft carrier flight deck personnel by providing training at FCAs for individual, teams, and multi-team coordination.
- Allow for single trainee, single team, and multi-team training opportunities for flight deck crews.
- Prevent stovepipe training solutions for flight deck crews.
- Target crew specific ALRE and flight deck parameters (e.g., Legacy Steam Catapults vs. Electromagnetic Aircraft Launch System (EMALS)).
- Include technologies that allow trainees to use realistic communications and equipment and provide an immersive environment for the trainee with the appropriate fidelity.

STATUS

- The Primary Flight Control (Pri-Fly) and Landing Signal Officer (LSO) Editions were delivered to the LSO School in NAS Oceana in FY18. The Catapult Launch Team was delivered to CNATT in FY18. Pri-Fly and Catapult Launch were delivered to Norfolk Naval Station in FY20 as part of the C-ARTS system. The Pri-Fly team is receiving updates and additional functionality in FY21-FY22.
- YouTube Link:

https://www.youtube.com/watch?v=OSQLBX2WUqI

MILESTONES

- **Final system:**
  - Pri-Fly Training Expansion Packs with connectivity to LSO and Catapult Crew
  - Software Baseline Architecture for connectivity of all future Training Expansion Packs
  - Ending technology readiness level (TRL): TRL Level 6
- **Documentation:**
  - User Manual
  - Technical Manual

HEADSET EQUIVALENT OF ADVANCED DISPLAY (N192-087)

OBJECTIVE

To develop through the SBIR program a novel Virtual Reality (VR), Augmented Reality (AR), and/or Mixed Reality (MR) headset that performs equivalent to or better than current flight simulator display systems. The headset will allow the pilot to see all cockpit instruments plus minimizes and/or eliminates any impacts to human factor qualities.

MR flight trainer

PROJECT DURATION
AUG 2019 – AUG 2023

SPONSOR
NAVAIR Small Business Innovation Research (SBIR)
PMA-205, PMA-209

POINTS OF CONTACT
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Benito Graniela (ATPOC)
John Hodak (PM)
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DESCRIPTION
Two companies (Holochip Corporation, Pison Technology Inc.) are independently working on SBIR topic N192- to develop a AR/MR headset customized for Navy flight simulators. Both headsets will provide out the window visuals which are equivalent to or better than current flight simulator display systems, and allow the pilot/user to see the actual cockpit displays along with their real hands. Holochip is developing a custom AR headset from scratch while Pison is customizing a COTS VR headset. Both headsets are expected to meet the topic requirements for flight simulators, but the Holochip headset also has potential applications for in flight operations since it's an AR headset.

NEED
Current display systems for aircraft flight simulators are extremely expensive and very large, require a lot of equipment, and are difficult to transport between different facilities. VR/AR/MR technologies are approaching the same level of performance as modern flight simulator display systems, and can eliminate the challenges of current display systems.

BENEFITS
Integrating a VR/AR/MR headset with a flight simulator will greatly reduce the cost and footprint of flight simulators, and could lead to mobile flight simulators that can be mass produced and deployed aboard ships or to bases around the world. The final products could extend beyond aircraft and military applications, into areas such as gaming, entertainment, and private sector training.

STATUS
Holochip started their Phase II In Jan. 2021, and demoed their first prototype in Aug. 2021. Pison started their Phase II in July 2021, and the kickoff was in Aug. 2021.

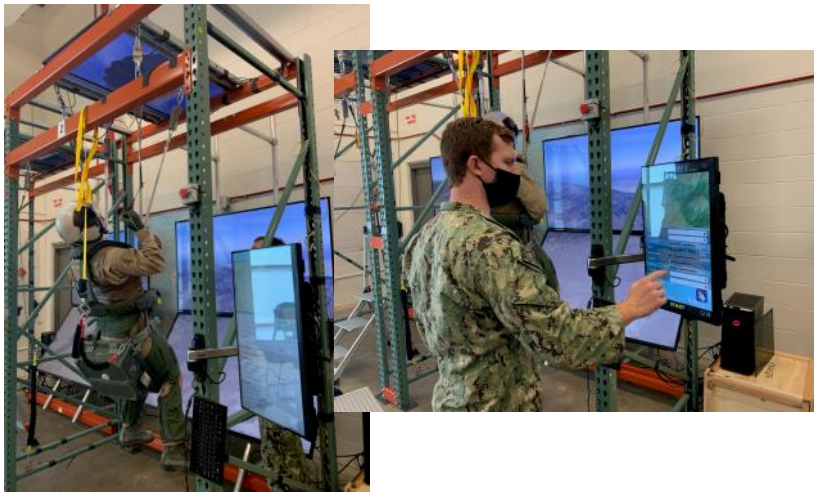
MILESTONES

- PH II - Pison customized a COTS high resolution VR headset with version 2 MR camera module which provides camera passthrough video to the user (March 2021). Version 3 MR cameras with a version 2 headset will be demoed in Dec. 2021
- PH II - Holochip has finalized a custom 6DOF tracker for their headset and demoed it in Aug. 2021. Will demo their first prototype of a custom multi-display AR headset in Q2 FY21.

IMMERSIVE PARACHUTE DESCENT PROCEDURE (PDP), MALFUNCTION, AND DECISION-MAKING TRAINING SYSTEM: SKYFALL (N161-007)

OBJECTIVE

Develop a novel reconfigurable device training system that provides immersive Parachute Descent Procedure (PDP), malfunction, and decision-making training to allow the survival training community to deliver cross-platform training without the need for multiple training systems or platform-specific peripherals.



Left: Aviation Survival Training Center leverage prototype parachute procedure trainer during feedback session for design refinement.

Right: Instructor interacts with built in operator station to identify triggers that inform diagnostic debrief at conclusion of training.

PROJECT DURATION

JUN 2016 - JAN 2024

SPONSORS

Naval Air Systems Command (NAVAIR) | Small Business Innovation Research (SBIR)

POINTS OF CONTACT

Beth Atkinson (TPOC)
John Hodak (PM)
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DESCRIPTION

This project is a Small Business Innovation Research (SBIR) project targeted at researching, designing, and developing a novel, immersive training system that provides the ability to train aviators by addressing three capabilities gaps: 1) training quality and effectiveness, 2) supportability, and 3) training realism. The training system should provide a reconfigurable interface that supports all Navy standard flight equipment and parachute equipment. Developed technology would provide the ability to demonstrate effectively both standard procedures (e.g., inflation of the life preserver, releasing the raft when applicable) and parachute malfunctions.

NEED

Current parachute procedure safety training is based on technology that has inadequate effectiveness and realism, primarily due to limitations that prevent interfacing with standard flight and parachute equipment. An advanced training solution will provide a reconfigurable connection for a variety of aircrew equipment and seat kits, which differ by platform.

BENEFITS

Cross-platform survival training, without the need for multiple training systems, will help avoid potential training costs, as well as allow aviators more flexibility within training systems. The increased fidelity of the training will also help aviators more effectively learn about PDPs, which are important survival procedures.

STATUS

This SBIR underwent a competitive source selection to award Phase I contracts, during which four contractors conducted feasibility analyses and designed/developed prototypes. The evaluation team recommended a gated Phase II award for two vendors to continue design and development efforts, resulting prototypes from Phase II base efforts. Through delivery and demonstration to personnel within the Naval Survival Training Institute, a single vendor solution was selected for continued development. Based on progress and maturity of technology, a Phase II.5 award is in progress that will support continued refinement to deliver a comprehensive prototype to meet end user community requirements for an expected transition via a procurement contract in FY23. The fleet continues to provide iterative feedback on the design and capabilities of the system through systems in use at 3 Aviation Survival Training Centers.

MILESTONES

- **Phase II:**
  - Phase II gated efforts were awarded for two vendors, resulting in a demonstration prototype
  - Phase II base period resulted in selection of a single Phase II vendor for the option period, with expansion funding
  - A multi-player arcade style game was developed based on the parachute trainer, which competed in the I/ITSEC 2018 Serious Game Challenge and has since been installed at a local video arcade for public use
  - Prototype test trainers have been delivered to Aviation Survival Training Centers (ASTC) for immediate use to support training of indoctrination and refresher students at ASTCs in Pensacola, July 2020 (3), Lemoore, October 2020 (1), and Miramar, August 2020 (1)
- **Phase II.5** awarded estimated to start in JAN 2022
  - Signed Technology Transition Agreement with PMA-205 in place

IN-HOUSE TRANSPORT DELAY KIT (219RR-21-003)

OBJECTIVE

To procure a transport delay test kit and develop in-house capability to test and troubleshoot system dynamic response in US Navy training systems.

Primary User Interface for the Transport Delay Test Kit (TDTK) Application

PROJECT DURATION

OCT 2020 - SEP 2021

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: Tech Transition

POINTS OF CONTACT

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Craig Snoderly (Co-PI)
Dr. Melissa Walwanis (PM)
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DESCRIPTION

The Transport Delay Test Kit (TDTK) is a data acquisition tool kit that is used to measure the transport delay on flight training systems. It consists of a sensor package including COTS accelerometers and photodiodes coupled with a specific application developed with LabVIEW software to measure and record transport delay times. Transport delay in a flight training device is a measurement of computational time between a control input, at the flight controls, and output cues, such as visual, motion and/or instrument responses.

NEED

The Aero Engineering Group is responsible for enforcing and maintaining system dynamic response requirements in US Navy training systems, but currently do not have in-house equipment available to measure and collect transport delay data on training systems. Controlling transport delay times between pilot inputs and visual/motion outputs is critical for reducing simulator sickness and pilot compensation to uncharacteristic response times. The need to redefine system dynamic response requirements and measure transport delay on existing training systems is slowly rising. Without in-house equipment the aero training systems group is dependent on the contractor to collect these measurements.

BENEFITS

The Transport Delay Test Kit (TDTK) provides the Applied Modeling and Simulation Branch the capability to measure and collect transport delay data from flight training systems. This tool will help troubleshoot and diagnose issues on training systems, direct program requirements, and ensure that our simulators are meeting Warfighter's training needs. The TDTK will also be used as a training tool within the branch to demonstrate proper transport delay test techniques and data analysis methods.

STATUS

This project is complete. The overall development and build of the TDTK was successfully accomplished and the measurement capability was validated on a P-8A Operational Flight Trainer (OFT). The TDTK is operationally ready for use and will provide the capability to collect transport delay measurements, analyze data, and support the pilot-in-the-loop aspects of training system performance.

MILESTONES

- Designed and Developed Transport Delay Test Kit (TDTK)
- Developed TDTK User's Guide
- Validated TDTK recording capability on P-8A Operational Flight Trainer (OFT)

NAWCTSD CYBER LAB (WFD:SG-20-005)

OBJECTIVE

The Cyber Lab was formed for a dual purpose: (1) to develop a persistent cyber research laboratory able to conduct experimental cyber training research and (2) develop a cyber test capability at NAWC TSD to coordinate and execute Cyber Table Tops, Cyber Risk Assessments and assessments on standalone and networked training platforms.

PROJECT DURATION
OCT 2018 - SEP 2020

SPONSOR
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD-SG

POINTS OF CONTACT
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Stephen Gaze (Co-PI)
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NCRC's Annual Capture the Flag event supported by NAWC TSD's Cyber Lab research

DESCRIPTION
The Cyber lab at NAWC TSD comprised of trained personnel on cyber threats faces by training systems as well as a dedicated space for training system assessments. The core capability provided by the cyber lab is personnel that are highly trained on the specific treats faced by training systems. The changing threat landscape requires constant training and the cyber lab is dedicated to maintaining personnel readiness. The cyber lab provides both technical assessments as well as a sandbox for forensic analysis in the event of a training system compromise.

NEED
There is a current need to better assess our training systems for cyber resilience. RMF and the ATO process are maturing to better understand the threat landscape. The realization that our training are often running operational code, model core capabilities, and are utilized in a persistent manner providing a more consistent attack surface for the enemy to exploit. Additionally these training systems are incorporated into the Navy Continuous Training Environment with live systems (including ship and aircraft combat systems) and could leave them exposed if proper cyber mitigations are not considered in design.

BENEFITS
The main benefit that the Cyber Lab provides is a trained workforce. This initial focus on training has allowed us to Improves Performance / Protection on our current systems. Additionally by providing cyber table top exercises for our training systems, key personal now have a better idea of the cyber threats and can mitigate them during system engineering lifecycle process. Lastly, the Cyber lab supports DoD's annual Capture the Flag exercise on the National Cyber Range.

STATUS
Currently the cyber lab is operational and can support CTTs and Cyber Training. We are working on a persistent Capture the Flag exercise to support the Cyber Security Workforce. Additionally, the Cyber Lab has space to support Cyber Risks assessments if required for RMF.

MILESTONES

- Train workforce (SANS classes, CTT Training, Reverse Engineering, Sec+, RMF)
- Lab Space and Infrastructure (Secured 200sq.ft. classified lab space in 1106)
- Cyber survivability (CTT class scheduled Feb.20th 2021)
- CRADA with Scalable Technologies – Training Cyber in LVC missions
- Supported SISO standards for Cyber Training – Cyber Data Exchange Model

RESEARCH TO ADVANCE THE ON-DEMAND HYPOXIA TRAINER (ODHT) FOR SURVIVAL TRAINING

OBJECTIVE

The effort seeks to continue research and development of a next-generation hypoxia-training device. The goals of this research includes analysis of average flow rate requirements, impacts of oxygen concentration on recovery, and continued development to enhance the system effectiveness and reliability.

Engineering testing of On-Demand Hypoxia Trainer with Aerospace Physiologists at NAS Pensacola to validate pressure on demand and initial training profile for hypoxia training.

PROJECT DURATION

MAR 2018 – SEP 2020

SPONSORS

Naval Aviation Training Systems Program Office, PMA-205
Defense Health Agency, DHA

POINTS OF CONTACT

Beth Atkinson (PI)
Dr. Melissa Walwanis (PM)
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DESCRIPTION

This effort seeks to empirically evaluate research questions about the On-Demand Hypoxia Training (ODHT) including: 1) the impact of variable oxygen concentration on recovery rates, 2) the effect of variable flow rates on breathing and experience of hypoxia symptoms, and 3) development to refine the product based on iterative Fleet validation testing. Finally, this effort will investigate parallels that can be drawn between the cognitive decrements associated with alcohol intoxication and those associated with hypoxia.

NEED

Hypoxia continues to remain a highly visible safety issue, with training being a significant part of the mitigation process. An ODHT prototype technology has been developed to overcome shortfalls in training. However, in order to ensure a successful transition of the OHDT, additional research is necessary. These proposed studies will provide results that are essential to inform the design, establish standard operating procedures, and validate the effectiveness and reliability of a novel prototype hypoxia trainer prior to procurement.

BENEFITS

The acknowledged success of hypoxia training makes it paramount that the Navy ensures that these capabilities remain available. In addition to providing a means for addressing the larger Navy research program to mitigate hypoxia physiological episodes, this effort will advance the lab's understanding of hypoxia training. Further, this effort will provide the means to thoroughly investigate a novel technology to determine the effectiveness and efficiency of the devices to deliver higher fidelity training opportunities.

STATUS

Following Institutional Review Board (IRB) approval, data collection was conducted to investigate average flow rate variations between individuals and impacts of oxygen recovery at various concentrations. In parallel with research efforts, the team continued to refine the design and development of the system regulator and other subassemblies based on Fleet validation testing. Follow-on research is being proposed to investigate breathing dynamics beyond hypoxia training (e.g., hyperventilation, air hunger). A procurement contract for approximately 40 units that will be delivered to the 8 Aviation Survival Training Centers (ASTCs) through FY22 was awarded in FY21. Initial delivery of units to ASTC Jacksonville took place in OCT 2021. Efforts are underway to expand the system.

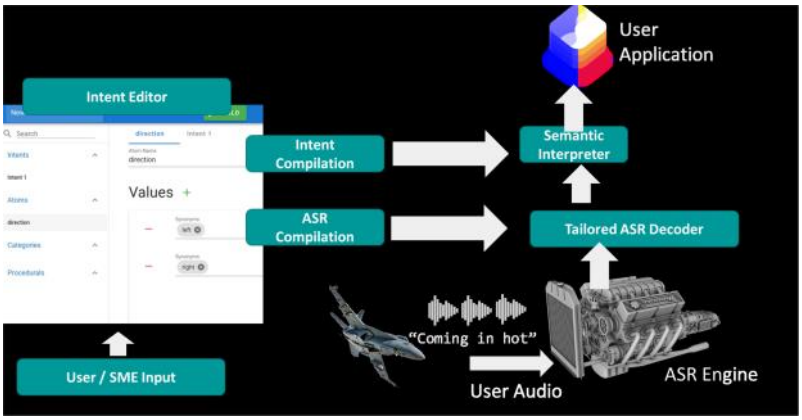
MILESTONES

- Presentations: Atkinson, Entinger, Tindall, Gilg, Scripture, Immeker, McEttrick, Sciarini, & Murr, (2018). A preliminary look at hypoxia compared to alcohol intoxication. Poster presented at AsMA 2018-Dallas, TX.
- Workforce Development: Mentored junior teammates on program management, data collection and analysis, and coordination with fleet customers.
- Phase III Procurement contract awarded
  - ◊ Initial delivery accepted OCT 2021, with deliveries expected throughout FY22

SOLILOQUY & THE SPEECH-ENABLED SIMULATION TRAINING ENRICHMENT TOOL (SESTET) (N17A-T010)

OBJECTIVE

Develop an innovative software capability to improve the utility of structured automatic speech recognition (ASR) by allowing end-users to customize the set of supported utterances without external support.



Soliloquy architecture

PROJECT DURATION

AUG 2017 - MAY 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Technology Transition (STTR)

POINTS OF CONTACT

Beth Atkinson (TPOC)
Dr. Emily Anania (Co-TPOC)
Dr. John Killilea (TPOC)
John Hodak (PM)
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DESCRIPTION

This project is focusing on developing an software capability to improve the utility of structured automatic speech recognition (ASR) that allows end-users to customize the set of supported utterances without engineering support. The resulting software capability should be modular and flexible in nature to allow multiple aviation platforms to leverage the functionality. For example, consider U.S. Naval aviation crews that conduct similar mission sets, but have their own unique doctrinal phraseology. Although each platform may prosecute an antisubmarine warfare (ASW) mission similarly, their doctrinal phraseology is likely specific to their respective platforms. The solution should have enough flexibility to account for platform specific changes, or multiple platform accommodations. The final capability should deliver full-pipeline solutions for automation speech recognition, natural language understanding, dialogue management, and automation response generation.

NEED

ASR successes within simulation-based training systems have been modest. Some domains have overcome the complex challenges that exist in implementing ASR by making use of enforced doctrinal phraseology, which speech recognition technologies can exploit. However, in more complex and fluid training environments that are less structured, more complex natural-language processing techniques are necessary to achieve that purpose. These environments require ASR systems with the flexibility for the instructor to customize and edit the feature.

BENEFITS

This effort seeks to provide a capability for end users of ASR-enabled training systems to edit or customize the feature to better match their particular needs, which is a significant system upgrade. Military domains are characterized by adaptation of tactics and protocols over time; given this, the technology should provide training personnel with functionality to append a particular phrase or a specific term to the existing grammar. This will decrease labor costs associated with creating language models and integrating ASR models within DoD systems.

STATUS

This STTR has completed a competitive Phase 2 period with multiple contractors. A Phase 2 Extension was awarded in May of 2021 to one contractor to continue tasking. Future tasking includes integration of the capability within a Fleet Speech Trainer (ROGER) as well as Science and Technology speech efforts targeting improving Automatic Speech Recognition and Natural Language Processing.

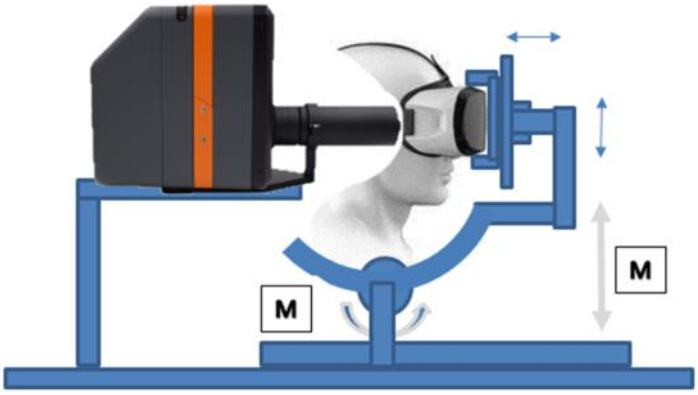
MILESTONES

- Phase 2 base closeouts concluded in early 2021
- One contractor awarded a Phase 2 expansion in May 2021
- User Interface / Usability evaluation conducted by Embry-Riddle Aeronautical University in late 2020. Recommendations are being incorporated in the new version of Soliloquy
- Integration of TRL5+ prototype of Soliloquy with a wide variety of DoD training system and other stakeholder applications

STRATEGIC DEVELOPMENT OF NEAR EYE DISPLAY (NED) PERFORMANCE METRICS FOR NAVAL AVIATION TRAINING APPLICATION (SG-19-022)

OBJECTIVE

Develop techniques, tools, and procedures for measuring performance of near eye display systems (NED), such as virtual reality (VR), augmented reality (AR), and mixed reality (MR) head mounted displays (HMD).



Concept Near-eye Display Imaging Colorimeter and AR/VR Headset Testing Mount

PROJECT DURATION

APR 2019 - SEP 2021

SPONSOR

PMA-205

POINTS OF CONTACT

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Ronald Wolff (ATPOC)
Dr. Melissa Walwanis (PM)
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DESCRIPTION

This project is looking at VR/AR/MR technology and adapting existing visual system measuring techniques and procedures to NED. The Navy is seeking collaboration with developers and system integrators to develop metrics and procedures that accurately quantify performance.

NEED

The popularity and advancing capabilities of commercial VR/AR/MR headsets has opened the opportunity for the innovative application to Naval Aviation Training Applications. However, current methods for assessing visual display systems do not necessarily apply to NED devices.

BENEFITS

Knowledge within the Navy on the pros and cons and applicability of VR/AR/MR devices to Naval Aviation missions is necessary. Technology is currently advancing quickly and it is therefore necessary to keep track of advances and capabilities and update a road map for further research and development projects. This project will generate the necessary Navy workforce knowledge and enable new subject matter experts to answer these questions.

STATUS

A laboratory was established lab at NAWCTSD for VR/AR evaluation. An initial set of VR/MR parameters were identified and research and documentation of metrics and procedures is underway. Work was coordinated with FSI and MFS efforts to ensure minimization of duplication of efforts across the government. VR and MR headsets were evaluate and results were documented in VR 2020 an I/ITSEC 2021 paper entitled *Adapting Flight Training Device Visual System Testing Methods to Extended Reality Near-Eye Displays.*

MILESTONES

- 219 WFD SD award 4/9/19.
- Established CRADA with FSI July 2019.
- Complete first set of field and lab metrics Spring 2020.
- Complete development of NED mount Spring 2020.
- NISE Sec 219 FY/20/21 Mid Year Review Spring.
- Baseline NED performance Summer 2020.

STREAMLINING THE 3D ASSET CREATION PIPELINE WITH RAPID MESH CREATION TECHNOLOGY (WFDSG-21-016)

OBJECTIVE

To utilize emergent, automated, rapid mesh creation software that will streamline the development process to reduce the cost and time of highly detailed, realistic, game/simulation ready, 3D modeling. A streamlined process will also help to develop re-usable contract-ready language to provide a description for game/simulation-ready assets as it pertains to Virtual Interactive Shipboard Instructional Tour (VISIT)™ and Multipurpose Reconfigurable Training System (MRTS)®.

Screenshot of 3D modeled valves and pipe fittings from VISIT® VR

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD-SG

POINTS OF CONTACT

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DESCRIPTION

The standard 3D modeling pipeline begins with a variety of source materials including photographs, videos, CAD drawings, and point cloud data from laser scans of the object to be modeled. Each of these source material options has their own drawbacks and therefore artists typically use a combination. Gathering source materials is time -consuming. To counterbalance these issues, this research seeks to streamline the remainder of the 3D modeling pipeline.

NEED

The volume of 3D modeling work requested of the TechRAT/VISIT™ and MRTS 3D® teams is increasing dramatically, due to the demand for graphics intensive AR, VR, and 3D applications for training. Creating the game/simulation-ready assets to support these development efforts is expensive and requires long lead times. Additionally, there is no standard for what constitutes a "game-ready" asset; an asset deemed ready for a 3D desktop application might not suffice for an XR application.

BENEFITS

Developing technical experts in photogrammetry, cad-to-mesh, and photo-to-mesh techniques will improve the TechRAT/VISIT™/MRTS 3D® asset creation process, decreasing training product delivery time in alignment with the Navy's speed to the fleet objective. This same expertise can be applied to the cost and time estimating activities associated with acquisition. Any team across all Naval communities can leverage this knowledge.

STATUS

There are two main areas of focus for this research. The first is to explore commercial software technologies to pinpoint their strengths and weaknesses. The second is to determine which of these technologies when combined will provide a more streamlined pipeline for 3D assets. All software items have been procured and are currently being reviewed.

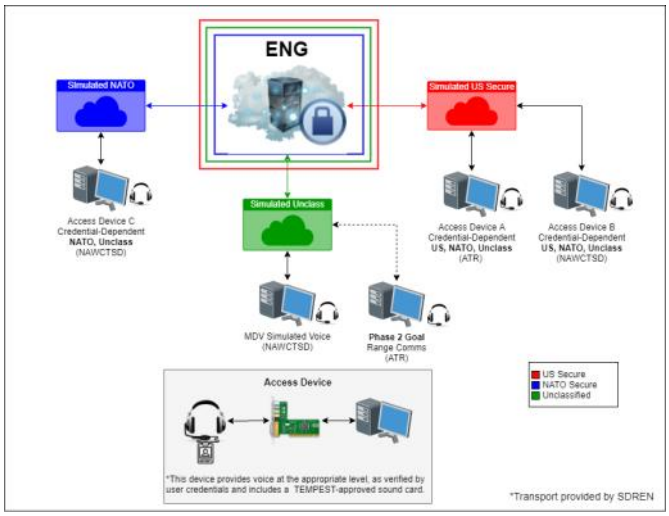
MILESTONES

- Procure software to be explored and distribute to the artists who will use them in concert with existing tasks
- TechRAT Engineers to familiarize with software features
  - Attend virtual onboarding sessions for those software companies that offer one
  - Review pre-recorded tutorials offered by software companies
- Contact collaborators to review their process
- Obtain input from artists and engineers using software regarding strengths and weaknesses
- Apply selected software and process to existing source material and compare results

TRAINING MULTI-LEVEL SECURITY FOR THE SURFACE/AVIATION INTEROPERABILITY LAB (SAIL)-ATLANTIC TEST RANGE (WFDSG-21-014)

OBJECTIVE

The goal of this effort is to develop and deploy a Government-owned Cross-Domain Solution (CDS) in the operational environment of the Atlantic Test Range (ATR). The project takes an incremental approach, beginning with the refinement of use cases and concluding with the deployment of a fully accredited system.



Voice Concept Architecture

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD-SG

POINTS OF CONTACT

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DESCRIPTION

The Atlantic Test Range (ATR) often requires a Cross-Domain Solution (CDS) in order to conduct multi-level security operations (MLS). Enterprise Network Guard (ENG) is anticipated to be the first Government-owned CDS to meet NSA's Raise the Bar (RTB) criteria, and may be an ideal solution for the many use cases at ATR. This project explores the CDS requirements of the ATR and configures ENG and its associated rule sets to meet those requirements, as funding allows.

NEED

The ATR benefits from a Government-owned CDS to meet its various MLS requirements and use cases. The ENG program benefits from an operational test and evaluation (T&E) and training environment to mature its technology.

BENEFITS

The Enterprise CDS deployed at ATR will provide a streamlined avenue to bring together assets from across security levels. This may improve security posture, increase exercise effectiveness, and/or enable more effective manpower utilization. This effort will also increase the maturity level of the ENG program.

STATUS

During FY21, the project will focus on gathering ATR use cases and furthering the capabilities of ENG by deploying and testing in simulated/emulated MLS environments. The project will leverage integrated lab exercises such as NILE. During FY21, ENG is anticipated to be an NSA-approved CDS, so the technology will be deployed to satisfy the requirements of ATR, as defined during the FY21 concept refinement.

MILESTONES

- **FY21:** Feasibility study that includes the following:
  - ◊ CDS use case(s) at ATR that can be supported by ENG within project resource constraints.
  - ◊ ATR rulesets, as required for voice transport will be implemented in NILE 21-1 as a proof-of-concept
  - ◊ Protocol analysis
- **FY22:**
  - ◊ Update ENG Baseline, schemas and supporting rulesets.

VOICE RECOGNITION TO SUPPORT ASSESSMENT OF CROSS-PLATFORM SITUATIONAL AWARENESS (SA) AND DECISION-MAKING (N202-098)

OBJECTIVE

Develop a voice recognition capability that can support analysis and debrief of Carrier Strike Group level decision making and Situational Awareness (SA).

Screenshot from NGTS ART

PROJECT DURATION

Phase I: 6mos Period of Performance

SPONSOR

Small Business Innovative Research (SBIR)

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DESCRIPTION

The goal of this project is to develop a tool to analyze virtual, and eventually live training events, using speech to text (STT) technologies and natural language processing (NLP) to verify automatically the semantic content of utterances associated with relevant tactical communications. Applying this type of technology to Air Defense integrated training will enhance assessment by providing more robust and accurate assessments. The tool will allow for natural, free flowing interactions between platforms, which will result in speech recognition and understanding among groups within context. Additionally, the tool should be designed and developed to include debrief visualizations that support diagnosis and feedback of voice communication tied to context in the tactical environment at the time of the communication.

NEED

There is a need for complex, highly coordinated, System-of-Systems, Air Defense missions and tactics cross-platform communications. The complexity of coordination associated with integrated tactics necessitates a significant amount of voice communications across the different platforms to provide Situation Awareness (SA) and elicit decision-making. Communication is critical to cross platform coordination and overall tactic execution, yet it remains one of the most challenging training objectives to meet during Air Defense events. Specifically, there are challenges with recognizing when a call or request for communication has been made (i.e., at a specific point in the timeline), ensuring timeliness of communications (i.e., time to respond to a request or provide required information based on environmental cues), and providing the appropriate brevity terms and standard communications protocols. The need for timely, diagnostic feedback specific to cross-platform communications becomes critical.

BENEFITS

The development of an innovative speech recognition tool for cross-platform SA and decision-making will benefit the Fleet by significantly decreasing instructor workload, reducing human error and manpower time requirements, and automatically provide instructors with information on communication protocol adherence and timeliness to improve SA and increase debriefing capabilities.

STATUS

In FY21 the government conducted evaluations of 33 Phase I proposals and down selected to three performers. Contracts were awarded to three companies in Q1 FY21 and kickoffs held. Phase I focused on defining and developing a concept for standalone, voice assessment capability for a single Air Defense platform and will demonstrate feasibility of application into the larger, integrated training system at the completion of Phase I. The government, down selected to one company, Knowledge Based Systems (KBSI), for the Phase I Option and Phase II, awarded in Q3 FY21. Phase II focuses on architecture/implementation and integration into Next Generation Threat System (NGTS)/ Analysis Reporting Tool (ART).

MILESTONES

- Phase I
  - ◊ Conducted evaluation of 33 Phase
  - ◊ Down selected to three companies
  - ◊ Contracts awarded in Q1 FY21 and kickoffs held
- Phase II
  - ◊ Down selected to one company, KBSI, for Phase I option and Phase II
- Contracts awarded in Q3 FY21 for option and Phase II award
- Performer received latest version of ART for integration

AUTOMATED NMETL ANALYSIS: WARFARE COMMAND & CONTROL KNOWLEDGE ELICITATION DATABASE (WC2KED) - BAR21-025

OBJECTIVE

To develop, prototype, and integrate a decision-making database tool to automate the analysis of Navy Mission Essential Task Lists (NMETL) for command and control (C2) of carrier strike group (CSG) missions.

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division
NISE | BAR

POINTS OF CONTACT
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Dr. Randy Astwood (Co-PI)
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DESCRIPTION
Contextualized cues will be combined with objective data and, when linked to decisions for Warfare Commanders (WC) at the NMETL level, will lead to improved Situational Awareness (SA) and better decision-making when used to debrief WCs. We will observe Live, Virtual, Constructive (LVC) Fleet training events, conduct interviews and focus groups with C2 subject matter experts (SME), and read documentation (e.g., OPTASKs, ROC/POEs) to determine sources of contextual cues available in LVC training environments. This will aid in understanding which contextual cues are relevant for specific NMETLs and how they are applied for desired C2 for WCs. We will integrate decisions database tools with Joint After Action Review (JAAR) capabilities and reports, implementing findings in NAVSEA NISE-funded Naval Surface Warfare Center Dahlgren Division (NSWCDD) Dam Neck Annex (DNA) product to automate NMETL analysis.

NEED
The department of the Navy has identified Training & Readiness (T&R) as a primary area for improvement. LVC Fleet training events provide limited after-action review capabilities with regards to objective decision-making measures for Fleet WCs, with little to no explicit information on how trainee decision-making compares to experts in their warfare area. Currently, there is little objective measurement or diagnostic debrief capabilities of higher level C2 in Fleet Synthetic Training (FST) Events for the Warfare Commander. Decision Making is seen as too contextually based to accurately, objectively measure or capture.

BENEFITS
This effort will enhance Fleet ability to identify opportunities for training and provide objective measurement linked to T&R.

STATUS
The team observed a FST-J event via NCTE. They were also able to interview Quantitative Fleet Feedback team members and JAAR Cell members during FST-J to identify training objectives and means to identify objective data needed for debrief. They also interviewed Mentor SMEs to identify CSG-15 Measures and NTAs. They also data mined chat rooms for Game control and MSELs/NMETLs to identify relevant doctrine to include in database. We provided data and feedback on user interface and data mining algorithm development to programmers at NSWCDD DNA.

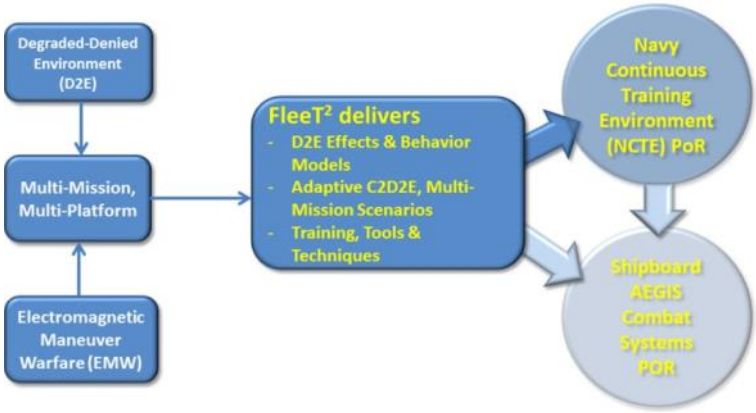
MILESTONES

- SEP 21: Prototype database with linking of cue values/configurations to C2 decisions and NMETs. This will enable experimental testing in Year 2.
- SEP 22: JAAR and ART reports; implementation of the process in NSWCDD DNA software; results of test and experimentation.

FLEET TRAINING TECHNOLOGIES (FLEET2)

OBJECTIVE

Currently, the Navy plans and trains for pristine Command and Control (C2) environments. While C2 is itself complex, the emergence of peer threats makes it even more difficult to ensure resilient C2 processes. In a Denied/Degraded Environment (D2E), adversaries may deploy a variety of tactics that create a dynamic environment, rife with additional challenges. Training in the absence of these realities presents a threat to effective C2—a crucial component of Naval surface operations. FleeT2 will provide new training approaches and technologies.



PROJECT DURATION

OCT 2017 - OCT 2022

SPONSOR

Office of Naval Research (ONR)
Code 34 Future Naval Capability (FNC)

POINTS OF CONTACT

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DESCRIPTION

FleeT2 is designed to allow trainers to build scalable phenomenology models and virtual assets to simulate, test, and train to emergent threats and technologies. The virtual constructive simulation capabilities planned for FleeT2 will allow the system to produce accurate, detailed, threat-dense, and intense scenarios that would be cost prohibitive or otherwise impossible to perform in the real world. Synthetic models can be easily modified, repeated, and adapted to train various situations, user roles, and skill levels. Ultimately, FleeT2 will allow command teams and system operators to train for integrated, cross-platform warfare against simulated peer threats with counter D2 capabilities.

NEED

Naval surface C2 is a broad domain encompassing the management of coordinated electronic surveillance, information integration across enterprise sensors and information sources, and personnel/asset management in support of missions. Understanding all the demands facing C2 performers is further complicated by the fact that C2 personnel operate at many echelons of command and across many specialized functional areas.

Creating the training systems and curricula necessary to support such a domain will be challenging.

BENEFITS

There are two anticipated benefits arising from the FleeT2 program. First, the Fleet will have a secure environment to train to address D2E threats. Further, the simulations will be extensible to evolving and emerging threats. Second, the Fleet will be able to train for D2E operations more effectively at a lower cost, which should result in a reduction in underway deployments required for training while providing an environment that mirrors the real world.

STATUS

FleeT2 has completed Year 2 of the FNC effort under ONR Code 34. Technology development for measures, blue force capabilities in JSAF, and degradation models is ongoing. FleeT2 conducted three Focused Test Events (FTE), two at Naval Simulation Center Pacific (NSCPAC), two at Naval Simulation Center Atlantic (NSCLANT) or Advanced Training Domain Lab (ATD), and two distributed across NCTE at Gallery Hall at NSWDDC DNA, NAWCTSD, and NSCPAC. An end of FY FST-RDT&E V&V was also conducted across sites, including NCTE at Robin hood Road, ATD/ NSCLANT, NAWCTSD, and NSCPAC to test technology integrated across NCTE RDTE. Technologies developed under this effort include enhanced performance measures in JAAR reports, red propagation visualizations using builder in SIMDIS and JAWS, enhanced Red Cell C2 structures, Communication degradation models, Satellite Jamming, AIS Spoofing, and Radar Jamming.

MILESTONES

- A Technology Development Agreement was signed between the Office of Naval Research (Code 341), OPNAV N96 (Director, Manpower and Training), Fleet Forces Command (N72), Program Executive Office Integrated Warfare Systems Integrated Training (1IT), and the Navy Continuous Training Environment, NSWC Corona (RS20F)
- Conducted (3) FTEs with Tactical Training Group Pacific (TTGP): 1) focused on Human Performance Measurement and JAAR) focused on Intelligent Agents for Zulu mentors and 3) focused on Red Cell and EM Propagation
- Conducted Subject Matter Expert (SME) workshop at TTGLP, NAWCTSD, and via focused Technical Interchange Meetings (TIM)

INTEGRATED COOPERATIVE ENGAGEMENT CAPABILITY (CEC) & OWNSHIP FOR NGTS-MISSION CAPABILITIES (ICON-MC) (TT-20-093)

OBJECTIVE:

This effort seeks to develop a Cooperative Engagement Capability (CEC) data link model, improve the AIM9X model fidelity, and conduct effectiveness studies to better understand the impact these fidelity improvements have on training.

NGTS Screenshot

PROJECT DURATION

OCT 2019 - SEP 2022

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: Topic 219TT-20-012

POINTS OF CONTACT

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DESCRIPTION

This effort seeks to increase the capabilities associated with internal NAWCAD assets to better support the ability to develop and test/ experiment with Science and Technology (S&T) products for complex air missions. Historically, NAWCAD has used the Manned Flight Simulator (MFS) facility to conduct these types of S&T activities as a proxy for operational environments. However, the traditional customer base for MFS are test pilots that use the high fidelity simulators to test aerodynamic characteristics of flight and capabilities such as weapon flyouts have not been required. Additionally, the simulation environment used at MFS, NGTS, does not simulate all the data links necessary to fully execute complex tactics like the Naval Integrated Fire Control-Counter Air (NIFC-CA). In order to make the MFS facility a viable option for conducting state of the art S&T in the Air Warfare domain, these gaps must be filled. Consequently, this effort proposes to enhance the F/A-18 E/F AIM9x ownship weapons model and to develop a CEC data link capability within NGTS to provide an organic experimentation and test capability. Additionally, this effort will conduct effectiveness studies to better understand the role model fidelity plays in skill acquisition.

NEED

To conduct experimentation and testing of S&T instructional training capabilities for complex Air Warfare missions and tactics, the simulation environment and ownship models in simulators must possess the appropriate fidelity and representative capabilities of the operational environment. Without these models complex integrated missions and tactics like NIFC-CA tactic kill chains cannot be fully trained (i.e., From the Sea), modeled, nor relevant S&T products accurately tested.

BENEFITS

By developing/improving these models, the NAWCs (AD/TSD) will continue to advance the state-of-the-art in modeling, simulation, and training technologies for complex Air Warfare missions/tactics by providing a more robust simulation environment that more accurately represents the operational environment.

STATUS

In FY 21, the team developed and tested an empirical study protocol - including finalizing measures. AIM9x baseline development was completed. We are finalizing the documentation analysis to begin development of CEC. In FY22, we will complete integration of the AIM9x baseline model, finish the CEC development, prepare to conduct an evaluation study, conduct evaluation study to determine fidelity improvements for training, and analyze and document findings in a report.

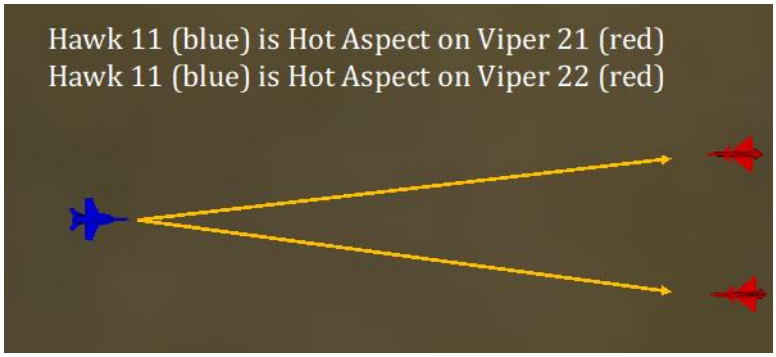
MILESTONES

- Ownship Weapons Model (AIM9x):
  - Defined requirements based on feedback gathered during AIM120 development on Integrated Warfighting Capabilities Fidelity Investigation (219BAR-17-013)
  - Completed AIM9X on-rail seeker and flyout model and began coding parser for MIL-STD 1760 messages in AIM9X interface control document
  - Developed draft model assessment document for SME testing

JOINED EVALUATION OF SIMULATION-ENABLED TRAINING FOR ENHANCED READINESS (JESTER) OSD11-CR1

OBJECTIVE

Develop a software capability to dynamically collect and assess performance data in real-time that will provide outcome data and contextual information regarding what was going on in the environment to enhance the information that instructors have available for debriefing trainees.



Screenshot from Event Recognition Capability In NGTS

PROJECT DURATION
APR 2019 - APR 2021

SPONSOR
Small Business Innovation Research (SBIR)

POINTS OF CONTACT
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DESCRIPTION
Conduct research, development, and testing of a new capability, compatible and integrated with the Navy's Next Generation Threat System (NGTS) that will enable dynamic performance assessments within Live, Virtual, and Constructive (LVC) training scenarios . This work builds prior effort designed to enhance algorithms and methods that perform rapid assessments of readiness including: 1) perform dynamic assessment as trainee's perform, providing real-time feedback to instructors, 2) take prior events and assessments into account when assessing new events, providing nuanced and tailored feedback, and 3) enable instructors to customize and to parameterize assessments to specific events, crews, and operating conditions.

NEED
Air Wing Fallon is one of the most important training opportunities in naval aviation that present trainees with live and live-constructive training events that display complexity not presented elsewhere. The scenarios are so rich and intense that teams of subject matter experts are employed to conduct the assessments of individual aircrews and to conduct debriefs. While debriefs themselves can stretch for hours, the preparation for debrief can take just as long. In the current evaluation structure all assessment and measurement is done by hand. As training events inevitably move to virtual environments a significant portion of this work can be offloaded from the human instructors. Thus, there is an opportunity to improve the current system by providing automated measurement through event recognition.

BENEFITS
This effort will include not only individual trainee assessments but unit and integrated level assessments. Extending assessment to the unit level will fill a critical gap in Naval training by allowing for more robust quality of instruction via debrief and allow Carrier Strike Group performance to be more effectively tracked over time and compared to one another to better understand proficiency and readiness prior to deployment.

STATUS
In FY21 the team: 1) Conducted site visit with Naval Air Warfare Development Center (NAWDC) to demonstrate event recognition capabilities to operational user communities, 2) Attended monthly integration test events with the Fleet Adaptive Multilevel Measurement for Operations and Unit Systems (FAM2OUS) IPT in the Weapons Systems Lab, 3) Augmented automated existing event recognition capabilities with in-situ digital manual tagging, 4) Enhanced White Cell NGTS Battle Monitor event recognition interface with interactive event visualization and service subscription interfaces, 5) Integration with NGTS Analysis Reporting Tool (ART) timeline for debrief activities, 6) Submission of event recognition code to NGTS team for incorporation into release build, 7) Discussion with FAM2OUS IPT to plan to incorporate machine learning and Big Data constructs.

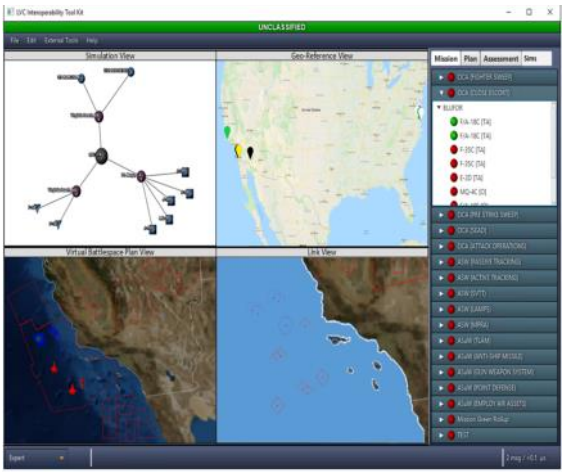
MILESTONES

- Demonstrated event recognition capabilities to operational NAWDC for user community feedback
- Monthly cycle of integration testing of the FAM2OUS toolset
- Continued and expanded development testing of JESTER event recognition capabilities with in-situ digital manual tagging and enhanced instructor-facing NGTS Battle Monitor interfaces
- End-to-end testing of JESTER events with the NGTS ART timeline
- Preparation of JESTER event recognition code for future NGTS release
- Initial study with FAM2OUS IPT of machine learning applications associated with event recognition data

LIVE, VIRTUAL, CONSTRUCTIVE-INTEROPERABILTY TOOL KIT (LVC-ITK) (RPC-21-006)

OBJECTIVE

Advance the LVC-ITK software to TRL 5/6 and beyond by integrating new mission profiles relevant to external collaboration partners, and use the software at multiple locations during distributed LVC training events.



LVC-ITK provides multiple graphical views and performs automated mission-based discovery, assessment, and validation of simulation objects during interoperability events.

PROJECT DURATION

OCT 2020 - SEP 2021

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE

POINTS OF CONTACT

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DESCRIPTION

LVC-ITK is a software application developed by NAWCTSD that addresses the recurring time/cost problem associated with distributed training event setup/integration by providing a persistent, mission-based assessment and validation tool. The tool has achieved TRL 5 through developmental testing in multiple laboratory federations, and is ready to advance to TRL 6 through use at multiple locations in distributed training events.

NEED

Navy simulations and simulator systems typically come together to support LVC research, experimentation, and training events in an ad-hoc fashion. This commonly requires significant up-front integration and development time and effort to achieve a successful training event. Federations often require lengthy/costly re-integration each time a simulation/simulator federate is upgraded, each time a new system is brought online, or when an exercise scenario requires connectivity or interoperability in a manner not previously integrated.

BENEFITS

The primary fleet impact is "Speed to the Fleet" – delivering products to the fleet faster. The product addressed by this effort is LVC training exercises and events. The difficulties described with distributed LVC setup/integration have existed and persisted for years. A tool such as LVC-ITK, which can be deployed for use across the Navy Enterprise and customized to troubleshoot particular mission sets, is a necessary element to achieve effective, persistent, on-demand LVC training capability. Readiness and Cost Reduction are secondary impacts that naturally follow from the enhanced training that will be enabled by LVC-ITK.

STATUS

LVC-ITK was issued a Major Application Authority To Operate (ATO) in August 2020, and the ATO is active. NAWCTSD coordinated with three collaboration partners, TTGP San Diego, NSWC Crane, and NUWC Newport to field test the software in their environments, using relevant mission sets, during Fleet Synthetic Training (FST) events and Naval Integrated LVC Environment Experiments (NILEX) during FY21.

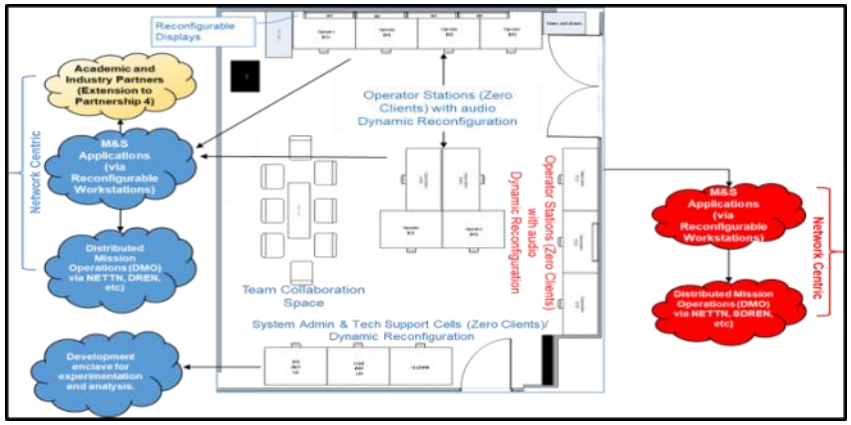
MILESTONES

- Customized mission sets to accommodate training missions relevant to NILEX 21 EABO and LRSuW Focus Areas.
- Used the application during NILEX 21-1 (objective) at NSWC Crane, and NAWCTSD Orlando with remote connectivity provided to the NUWC Newport Virtual War Room.
- Worked with NCTE to integrate LVC-ITK with the west coast NADTC for use during FST-A training events at TTGP San Diego.
- Collaborators provided feedback on the efficacy of LVC-ITK during their exercise, and provide a listing of desired features and/or enhancements to inform follow-on development.

NON-PERSISTENT VIRTUAL MACHINES (VM) VIA INSTANT CLONING FOR LVC (SG-21-018)

OBJECTIVE

Develop workforce knowledge and expertise in the technology area of Non-Persistent Virtual Machines via Instant Cloning and use the NAWCTSD Live, Virtual, Constructive Development & Operations Center (LVCDOC) to demonstrate the benefits of such an architecture when applied to LVC simulation applications.



The LVCDOC zero client-based virtualized LVC environment to which VM instant cloning will be applied.

PROJECT DURATION
OCT 2020 - SEP 2022

SPONSOR
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD-SG

POINTS OF CONTACT

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DESCRIPTION
The workforce participants will research methods to configure and implement instant cloning technology using the virtualized hardware/ software available in the LVCDOC. Base operating system images will be built and secured using the applicable STIGs, and those images will become the basis for clones. Simulation applications will be installed on the base images in a manner that prioritizes flexibility. The system will be tested and demonstrated by rapidly cloning simulation applications across zero clients in the LVCDOC, and then rapidly changing to a new configuration.

NEED
Although the implementation of Instant Cloning in commercial Virtual Machine architectures is well-understood, that is not the case when applying the technology to specific LVC training applications (e.g. NGTS, AMIE, JSAF, JBUS, JAAR, etc.). These applications often have computing and OS configuration requirements that are outside the norms of typical commercial applications, and they are typically tested on specific baseline OS and hardware configurations. The challenge is getting each particular application to function correctly and reliably in an environment for which they were not originally designed. Implementation of this technology at NAWCTSD will provide in-house developed systems and laboratories, such as the LVCDOC, to more flexibly scale and meet demand associated with LVC events.

BENEFITS
One purpose of this effort is to develop workforce knowledge and expertise in Virtual Machine technology, implementation of Instant Cloning, and the application of those concepts to LVC training applications. The breadth of LVC efforts taking place at NAWCTSD (including RDT&E and Acquisition) provides many areas for the individuals who are involved in this project to promulgate the knowledge and experience gained.

STATUS
We selected and installed NVIDIA vGPU graphics cards and created a Window SHB STIG'd baseline OS image configured for Instant Cloning. We also developed a Modeling and Simulation (M&S) Configurator application to automatically configure simulation applications upon startup.

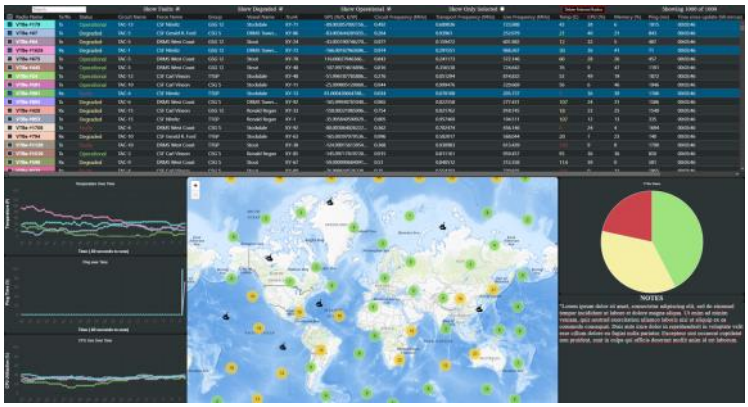
MILESTONES

- Non-Persistent VMs via Instant Cloning are demonstrated by running multiple simultaneous instances (five or more) of two or more different LVC simulation applications on Microsoft Windows (threshold) and RHEL (objective) base operating systems.
- LVC simulation applications that will be considered for demonstration include NGTS, AMIE, JSAF, JBUS, MDV, and JAAR.
- Instances of each simulation application shall be accessed on zero clients, and the graphical user interfaces of each application shall perform in a smooth and usable manner.
- The VM baseline, configuration, software licenses, and graphics hardware will be delivered to the NAWCTSD LVCDOC.

VIRTUAL TACTICAL BRIDGE EMBARKED (VTBe) AUGMENTED STATUS HUB (VASH) (RPC-21-011)

OBJECTIVE

Advance the remote status capabilities of VTBe via creation of the VASH tool. Integrate into the VTBe micro services model for remote procedure call and status display for discovery, operational status information display, and curated control for training mission operators.



VASH Operational Dashboard

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: RPC

POINTS OF CONTACT

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DESCRIPTION

Virtual Tactical Bridge-embarked (VTBe) Augmented Status Hub (VASH) is a software tool with auto discovery capabilities and real-time status/configuration display of embarked VTBe devices and bridges. Emerging LVC technologies like Virtual Tactical Bridge-embarked (VTBe) have established a new embarked training capability previously not available to the fleet. With VTBe, the fleet can begin to develop new training techniques and objectives based on the coming extension of voice to the virtual battle space while underway and beyond the horizon. This new capability carries an augmented need for better visualization of the configuration and status of components utilized to bridge Live-Virtual (LV) domains.

NEED

Prototype VTBe pack up kits are currently in use by the fleet. A persistent onboard solution – Virtual Tactical Bridge Embarked Synthetic Radio (VTBeSR) – will soon begin scaled deployment to the fleet. Experimentation, prototyping, and demonstration events thus far have not attempted to operate to the level that utilization will soon demand. Without a high level central status and management platform like VASH, fleet training planning will grow too difficult to organize for larger distributed events. VASH is conceptualized and intended to be a compatible participant of the emerging Distributed Global Planer (DGP) philosophy also under development at the Concept Development and Integration Laboratory (CDIL) within NAWCTSD Orlando.

BENEFITS

This technology will help the fleet, mission planners and event operators, to more accurately observe the real time status of the complex array of geographically dispersed system components.

STATUS

This effort kicked off in 2021 and is expected to run through FY22. First year efforts achieved a critical design and implemented the application front end. Second year efforts include backend implementation and demonstration.

MILESTONES

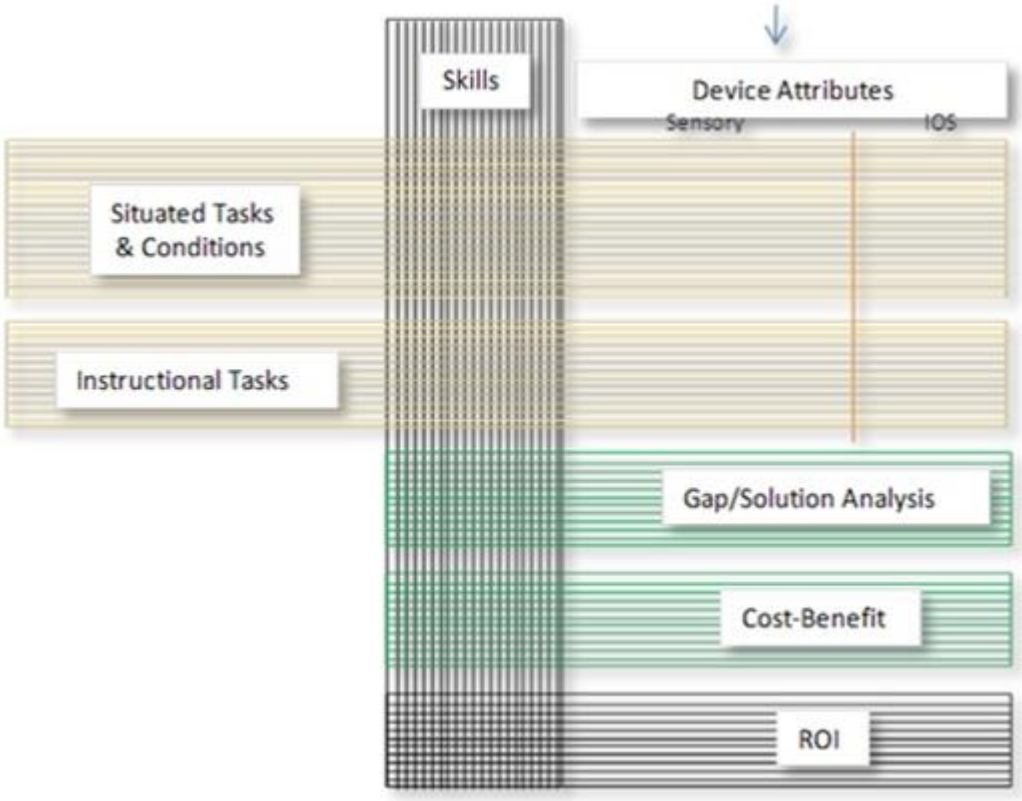
- FY21 Goals — Clear definition of requirements and use case definitions. Critical design capture and performance data collected and analyzed. Establish developmental laboratory test bench.
- FY22 Goals — Completed software development, tested and documented. Use during a live Fleet Synthetic Training event and results data collected/analyzed.

CORE CAPABILITY 4:
HUMAN SYSTEMS ANALYSIS, DESIGN, AND EVALUATION

NAWCTSD supports and improves human performance through the analysis, design, evaluation, and acquisition of cost-effective training solutions that are both responsive and proven to meet learning, performance, and readiness requirements. This capability is utilized across aviation, surface, undersea and cross warfare domains. Through the application of analytical methods, grounded design theories, and instructional design principles, analysts conceptualize, evaluate, and optimize the design and implementation of training systems and pipelines.

The following Technology areas comprise this Core Capability:

- Content Design
- Training Optimization Analysis
- Training Effectiveness Evaluation (TEE)

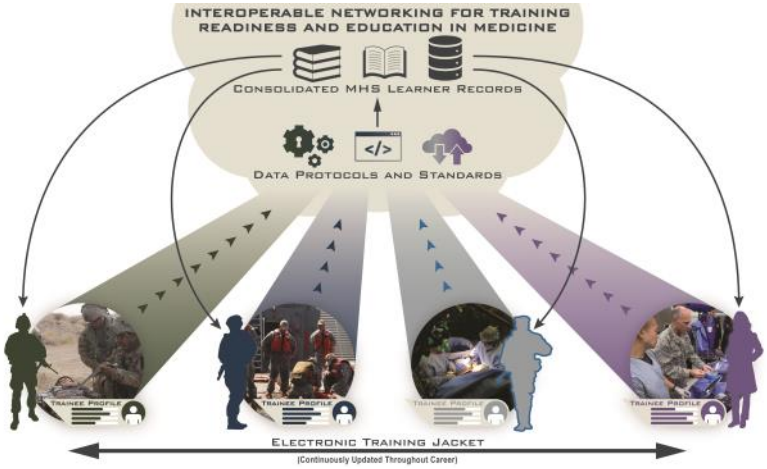


INTEROPERABLE NETWORKING FOR TRAINING, READINESS, AND EDUCATION IN MEDICINE (INTREMED)

(FORMERLY THE MHS TOTAL LEARNING ARCHITECTURE (TLA))

OBJECTIVE

Interoperable Networking for Training, Readiness, and Education in Medicine, or INTREMED (formerly the MHS Total Learning Architecture (TLA)), is a joint effort between the Defense Health Agency (DHA) and NAWCTSD to develop a system of systems designed to interoperate with existing training, education, and data management systems across the Military Health System (MHS) to aggregate data into in a centralized location.



PROJECT DURATION

OCT 2018 – JAN 2022

SPONSORS

Defense Health Agency Training and Education Directorate (J-7) and the Program Manager for Medical Simulation and Training (PM MST)

POINTS OF CONTACT

Erin Baker (PI)
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DESCRIPTION

Interoperable Networking for Training, Readiness, and Education in Medicine, or INTREMED (formerly the MHS Total Learning Architecture (TLA)), is a joint effort between the Defense Health Agency (DHA) and NAWCTSD to develop a system of systems designed to interoperate with existing training, education, and data management systems across the Military Health System (MHS) to aggregate data into in a centralized location. Integrated data will be standardized to ensure seamless data exchange throughout the system. With INTREMED, the DHA and the MHS can harness an interoperable network of disparate systems in a manner that will benefit all stakeholders within the military medical community. Aggregated data visualizations and dashboards at the service and enterprise levels will support decision-makers with insights they need to make strategic moves to improve service and total force readiness.

NEED

The MHS currently has an incomplete training enterprise infrastructure, which includes analytics for training, education, and human performance. Currently, the large number of legacy disparate systems in place collect a significant amount of data throughout the MHS continuum but have no ability to report enterprise-wide education, training, and human performance metrics. The MHS also lacks sufficient connectivity to provide data, information exchange, and analytics. The MHS requires alignment of all education, training, and human performance-related functions to prevent further threats to readiness and workforce excellence.

BENEFITS

INTREMED is being designed to address existing training and education performance gaps and ensure medical readiness is measurable and achievable. Designed to support the alignment of all learning and performance-related functions, this infrastructure will provide the structure and specifications to carry out all of the key training, education, and performance improvement activities for the military medical workforce under the purview of DHA in coordination with all of the military branches. INTREMED will improve military medical readiness by streamlining the processes for lifelong competency development and maintenance of the military medical providers.

STATUS

FY 21 of this effort resulted in:

- Data Driven Performance Measurement Strategy
- MHS Interoperability Analysis
- Market Research Analysis
- 24/7 Sandbox Testing Environment with USA Learning

MILESTONES

- Data Driven Performance Measurement Strategy
- MHS Interoperability Analysis
- Market Research Analysis
- 24/7 Sandbox Testing Environment with USA Learning

OCEANOGRAPHY TACTICS TRAINING FOR EMPLOYMENT READINESS (OTTER) (N182-119)

OBJECTIVE

Develop a software-based tool to rapidly generate web-based animated training content for employment of advanced oceanography tactics and is capable of incorporating adaptive content presentation based on learner progress through knowledge assessments.

TRITON Systems Inc., example of animated training scenario.

PROJECT DURATION

APR 2019 - MAR 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Technology Transfer (STTR)

POINTS OF CONTACT

Mitchell Tindall, Ph.D. (TPOC)
Beth Atkinson (Co-TPOC)
John Hodak (PM)
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DESCRIPTION

The Navy's crawl-walk-run approach to aviation training provides learning opportunities through mixed media beginning with classroom lectures and computer-based training, engagement with equipment through individual and part task training, and finally aircrew training in high fidelity simulation-based or live environments. Early computer-based training focuses on very specific foundational skills and teaches them in a vacuum. To address this issue, the Navy advocates building a capability that allows instructors or Subject Matter Experts (SME) to easily build training scenarios that are immersive and interactive physics-based animations and models.

NEED

This effort addresses the unidimensionality of early computer-based training by providing opportunities for trainees to start combining and building upon skills. The goal is to increase the accessibility of remediation or advanced skill development training opportunities by providing instructors with tools to rapidly develop web-based training content that animates advanced oceanography tactical employment to provide learners with the opportunity to remediate challenging skills and/or increase their skill base. Additionally, the capability should allow instructors and SMEs to build in assessment and consider intelligent tutoring functionality to ensures trainees have a degree of mastery before moving forward.

BENEFITS

Navy leadership has called for technologies that help to advance the Navy's crawl-walk-run approach to aviation training. This effort seeks to provide learning opportunities through mixed media beginning with classroom lectures and computer-based training, engagement with equipment through individual and part task training, and finally aircrew training in high fidelity simulation-based or live environments.

STATUS

This effort is currently in its Phase II option period. The kickoff for the Phase II base period was conducted in early December FY20 at the contractor's facility in Madison, VA. The contractor enrolled in the SBIR/STTR Transition Program (STP) for FY20-21. A progress update meeting and demonstration is scheduled for DEC FY22.

MILESTONES

- **Phase I:**
  - Proposals from 14 vendors were evaluated for technical approach, qualifications, and commercialization
  - Three contractors were selected for Phase I awards
  - Kickoff meetings are scheduled for early November
  - Base period closeout briefs will be held in early March
- **Phase II:**
  - Phase II kickoff meeting was held in DEC 2019
  - Software and prototype development shall continue until JUL 2021
  - Phase II Option award JUL 2021

ARCHIMEDES (N17A-T004)

OBJECTIVE

The objective of this project is to develop an intelligent tool to aid researchers in finding and synthesizing learning and cognitive science literature and providing compelling, data-based information and visualizations to support training system acquisition decisions. For example, the tool would support analysts trying to answer questions such as: "What training system fidelity is needed to facilitate learning and transfer?"

Navigation, search results, and visualizations facilitating synthesis and understanding of complex learning science literature

PROJECT DURATION

SEP 2018 – DEC 2021

SPONSOR

Naval Aviation Training Systems Program Office, PMA-205
Naval Air Systems Command (NAVAIR) Small Business Innovative Tech Transition Research (STTR)

POINTS OF CONTACT

Dr. James Pharmer (PI)
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DESCRIPTION

This Phase 2 STTR effort will result in a cloud-based tool leveraging a learning science ontology to support intelligent literature search, analysis, synthesis, and reporting of complex information. The tool provides users with:

- guided query formation and expansion supported by topic mapping visualizations.
- literature results review through intelligent paper markup and annotation.
- synthesis, characterization, and visualization of data and
- relationships across multiple papers.
- Exportable results (e.g., table of structured notes taken across papers).

NEED

The work performed for this effort supports the Advanced Instructional Techniques Technology Area.

BENEFITS

The tool will improve training system quality by assisting users in extracting, synthesizing, and providing learning and cognitive-science based evidence for acquisition-related recommendations. Users--analysts and decision makers--will gain a more comprehensive understanding of issues related to a query; not only theoretical and empirical evidence synthesized to support an "answer" to the query, but also an understanding of, e.g., gaps in the research, who is performing related research and within which organizations, what trends are exhibited in research over time. Information of this type is especially relevant when dealing with cutting-edge technologies.

STATUS

Two performers are in Year 2 of Phase 2. One performer is near the end of the period of performance, entering option tasking, while the other is extending the period of performance at no cost.

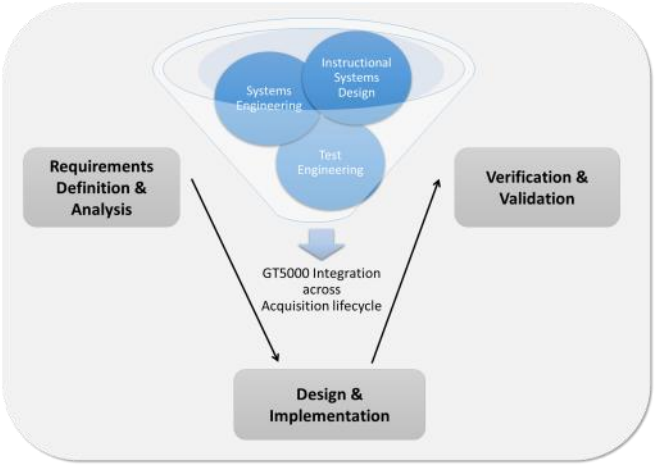
MILESTONES

- Functional end to end prototype demonstrations providing a basic suite of usable features for use by stakeholders and users.
- Spiral development to add ability for users to: create, manage and share distinct workspaces, Ability for users to create workspace-specific labels and notes, Visualization of topics for papers chosen for the workspace, Ability to capture notes while viewing/reading a paper, Ability to compare and filter papers based on notes and labels.
- On-going software releases.
- User feedback and usability evaluations.
- Tool deliveries Dec 2020 and Dec 2021.

CAPABILITIES-BASED ACQUISITION FOR TRAINING SYSTEMS—INTEGRATED TRAINING (TR-20-003)

OBJECTIVE

The goal of this effort is to develop and implement cross-competency training courses in the areas of: Training Needs Analysis, the Transition from Analysis to Design Documentation focused on Capabilities, and the Test and Evaluation of Training Systems based on Capability Requirements. Intended audience of training is currently scoped to members of the RDT&E (GT5000) workforce with anticipated growth across more disciplines.



CBA—integrated training of GT5000 workforce

PROJECT DURATION

OCT 2019 – SEP 2021

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD:TRG

POINTS OF CONTACT

Tiffany Parrish (TPOC)
Dr. Melissa Walwanis (PM)
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DESCRIPTION

The Capabilities-Based Acquisition for Training Systems—Integrated Training course provides cross-functional training designed to enhance GT5000 workforce knowledge, skills, and abilities (KSA) related to the acquisition of training systems. Through this course of study, individuals will gain skills in training system requirement definition and analysis, design and implementation, and verification and validation. Unique to this course, participants will gain familiarization with the roles and responsibilities of Instructional Systems Designers, Systems Engineers, and Test Engineers, along with opportunities for collaboration across functions.

NEED

VADM Grosklags and NAVAIR leadership have expressed the need for "speed to the Fleet" and for capabilities-based acquisition. NAVAIR (Mr. Newton) has also pressed for hands-on training in the Integrated Product Team (IPT) environment to better support the Mission Aligned Organization (MAO). As deliverers of capabilities-based training systems, GT5000 employees need more specific training on approaches to capabilities-based acquisition and opportunities to better integrate products and processes across disciplines.

BENEFITS

Improvement to training IPTs' ability to meet rapid acquisition and capabilities-based acquisition through enhanced collaboration across GT5000 and resulting improvements in acquisition products and processes.

STATUS

In FY20, the effort began by establishing a cross-functional Subject Matter Expert (SME) team and creation of a Wiki SharePoint for SME collaboration, project tracking, and configuration management of deliverables. Defined course objectives and learning objectives for all modules, outlined course conduct plan, and developed content for first half of course — 2.5 days for Requirements Analysis and Definition module. Briefed effort to PMA205 leadership and senior leaders of Competency.

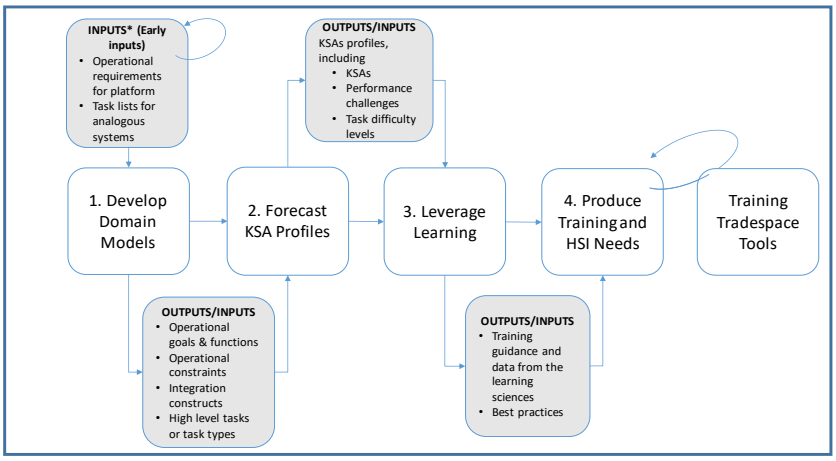
MILESTONES

- Defined Course Objectives and Learning Objectives for the Requirements Definition and Analysis, Design and Implementation and Verification/Validation modules
- Developed 2.5 day content for Requirements Analysis and Definition (ISD Competency)
- Briefed effort to PMA205 leadership and garnered interest in expansion of work outside of RDT&E
- Preparing for pilot roll out of learning objectives and course content with the intent of obtaining feedback focusing on within discipline content is effective and across GT5000 personnel collaboration is highlighted. Will modify as necessary
- Once course is finalized will conduct full course with students, preferably from IPTs

FUTURE VERTICAL LIFT (FVL) TRAINING CONCEPT

OBJECTIVE

Develop a corpus of training guidance that can be applied to the FVL program, in particular to the Army Future Long-Range Assault Aircraft (FLRAA) variant. Demonstrate that the Training Requirements for Rapidly Acquired and Complex (TRRACS) methodology is responsive to training design challenges associated with the accelerated acquisition of advanced complex technologies by leveraging analogous platforms.



TRRACS Process for the Early Identification of Training Requirements

PROJECT DURATION
SEP 2019 - SEP 2021

SPONSOR
Department of the Army
Program Executive Office, Aviation
Future Long Range Assault Aircraft (FLRAA) Project Office

POINTS OF CONTACT

Dr. Mitchell Tindall (PI)
Beth Atkinson (Co-PI)
Dr. Melissa Walwanis (PI)
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DESCRIPTION
The Future Vertical Lift (FVL) program is a multiservice initiative to develop the next generation of helicopter technologies. The purpose of this effort was to test the Training Requirements for Rapidly Acquired and Complex Systems (TRRACS) methodology through the application of the CH-53K and V-22B use cases. These analyses support the development of FVL-relevant training requirements in step with accelerated acquisition timelines. Analyses focused on identifying requirements that prepare operators and maintainers for warfighting characterized by integrated operations that rely on use of advanced technologies.

NEED
Accelerated acquisition stresses traditional methods for training system development because it forces key decisions regarding the skills to be trained and media selections to be identified before technical platform design details are known or even before a specific platform has been selected for development. This is further complicated with modern systems that rely on advanced automation and autonomous systems that may not have existed in the predecessor aircraft.

BENEFITS
This research provides the Army FLRAA program, and other FVL stakeholders, with a holistic and agile approach to training systems needs. The TRRACS methodology allows for linkages between complex Knowledge, Skill and Attitude (KSA) profiles to execute tasks associated with advanced technologies with empirically supported instructional approach best practices and training technologies for decision making early in the acquisition cycle.

STATUS
The results of the analyses demonstrated that the use of analogous platform use cases with the TRRACS methodology can successfully define design challenges of advanced complex technologies early in the acquisition timeline. FY21 efforts for this effort focused on expanding previous front end analyses on early training solution planning through media and fidelity analyses to identify critical KSAs and associated critical attributes in traditional and advanced training media types to support the training. Analysis efforts in FY21 focused solely on maintenance training needs. Results are documented in a series of spreadsheets, presentation materials, and final summary report.

MILESTONES

- Refined the TRRACS methodology and tested its applicability on multiple analogous platform use case analyses for pilots and aviation maintainers
- Developed multiple technical reports on the findings from CH-53K and V-22 for pilot and maintainer analyses
- Conducted numerous high visibility, senior level briefs and built consensus among stakeholders from a variety of competencies and agencies.
- Developed modified approaches to future media, fidelity and trade-off analyses to further define training needs and technology solutions unique to the Army FLRAA variant

CHIEF OF NAVAL AIR TRAINING (CNATRA) TH-57 VIRTUAL REALITY (VR) TRAINING EVALUATION

OBJECTIVE

Investigate the use of virtual reality technology, Helimod Mark III, to support self-study, event preparation, and event remediation in order to enhance performance for TH-57 student naval aviators (SNA) at Chief of Naval Air Training (CNATRA).

PROJECT DURATION

OCT 2019 - MAR 2021

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR & Naval Aviation Training Systems Program Office, PMA-205

POINTS OF CONTACT

Dr. Ada Mishler (PI)
LT. Michael W. Natali, MSC, USN, Ph.D.
Dr. Melissa Walwanis (PM)
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DESCRIPTION

Ryan Aerospace's rotary VR trainer is being evaluated in support of the TH-57 curriculum. An analysis of the syllabus will be completed and scenarios developed. During the evaluation, SNA feedback and performance will be collected for comparison between Helimod users and non-users. The purpose of this evaluation is to inform CNATRA leadership on the effectiveness of virtual reality (VR) devices to improve training and desired training outcomes (e.g., performance in the aircraft, reduction in re-flies) for the TH-57 community.

NEED

- Operational Requirement: NASMP IV Priority 5: "Continue strategy refinement to provide a basis of understanding the potential for leveraging technology to solve the training challenges of the future."
- PMA-205 Strategic Initiative to investigate utility of Virtual and Augmented Reality.

BENEFITS

If effective, the Navy could incorporate the VR devices in the CNATRA curriculum as supplemental, part-task training. These devices have the potential to provide training opportunities for stages that currently only use live aircraft training. Potential benefits include additional training utility and practice time, decrease in training costs, and increase in student performance within the aircraft.

STATUS

In FY21, Frasca was contracted to develop the flight model to be incorporated within the trainers. Aero model acceptance testing occurred along with additional device fixes. Experimental design was finalized, curriculum analysis completed, and flight scenarios developed. In FY22, data collection will begin followed by analyses and summary of the findings.

MILESTONES

- FEB 2020: TH-57 Ryan Aerospace Helimod Mark IIIs were delivered to NAS Whiting Field
- JAN - JUL 2021: Frasca was contracted to develop a TH-57 Aero model
- JUN - AUG 2021: Evaluation plan was revised and data collection measures were developed
- AUG 2021: Delivery and acceptance of Frasca's TH-57 aero model
- AUG - SEP 2021: Curriculum analysis was completed and flight scenarios were finalized

CHIEF OF NAVAL AIR TRAINING (CNATRA) T-6B VIPER® EVALUATION

OBJECTIVE

Develop and investigate the incorporation of the Virtual Instructor Pilot Exercise Referee (VIPER®) capability into primary aviation training at Chief of Naval Air Training (CNATRA). Discovery Machine, Inc. is adapting VIPER for naval aviation primary training, and NAWCTSD will examine the effect of scheduled VIPER practice on student naval aviator (SNA) flight performance.

VIPER Instructor Dashboard

PROJECT DURATION

SEP 2019 - DEC 2021

SPONSOR

Naval Aviation Training Systems Program Office, PMA-205 & Naval Air Warfare Center Aircraft Division (NAWCAD)

POINTS OF CONTACT

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Dr. Ada Mishler (Co-PI)
LT Michael Natali, Ph.D. (PM)
Jeffrey Llewellyn (PM)
ORLO_PDRT@navy.mil

DESCRIPTION

Discovery Machine, Inc. is adapting their Virtual Instructor Pilot Exercise Referee (VIPER®) for the T-6B virtual reality part-task trainers (VR-PTTs) used by Chief of Naval Air Training (CNATRA) for primary student naval aviators (SNAs). During the VIPER® evaluation, SNAs will be scheduled to practice in the T6B VR-PTT with or without VIPER® feedback. The research team will use the resulting data to examine the effectiveness of the T6B VIPER® for improving SNA performance, including reflys, unsatisfactory flights, event grades, and time to train.

NEED

· 2018 National Defense Strategy requirement: integrate technology to enhance readiness

· Naval Aviation Simulation Master Plan (NASMP) IV Priority 5: refine strategy to "provide a basis of understanding the potential for leveraging technology to solve training challenges"

· PMA-205 Strategic Initiative: Investigate the utility of Virtual and Augmented Reality

BENEFITS

This evaluation will produce objective training effectiveness data that will inform the use of virtual reality (VR) instructors in aviation training. By contributing to the military's knowledge of VR training best practices and enhancing self-practice opportunities for SNAs, it has the potential to reduce training cost per SNA, increase training pipeline throughput, and improve pilot performance to enhance safety and mission effectiveness.

STATUS

In FY21, a total of 41 VIPER maneuvers were validated and delivered, of which 33 were modified and 8 developed according to subject matter expert (SME) feedback. VIPER was migrated to Prepar3D Version 5.2 and installed at CNATRA with login control via authorized user CACs. Discovery Machine, Inc. worked with SMEs in an iterative process to address issues identified during the evaluation. Currently the Navy team is analyzing performance data and SNA feedback on the usability and utility of the system.

MILESTONES

- JAN 2020: Deliver initial maneuver set for instructor pilot (IP) testing
- MAR 2020: Revise maneuver set delivered
- APR 2020: Conduct bug fixes, airport support, and CAC-based login control delivered
- AUG 2020: Receive IRB approval for evaluation
- SEP 2020: Deliver new maneuvers and Prepare3D V.5 software upgrade to CNATRA
- OCT 2020: Begin IP maneuver feedback sessions
- NOV 2020 - SEP 2021: Conduct data collection and focus groups
- DEC 2020 - AUG 2021: Develop additional 8 maneuvers
- OCT - NOV 2021: Analyze performance data and SNA feedback
- NOV - DEC 2021: Document results in Technical Report

Evaluating and Improving the Naval Aviation Survival Training Program:
Evaluation of Spatial Disorientation Curriculum Enhancement

OBJECTIVE

Perform a training effectiveness study of the Spatial Disorientation (SD) curriculum in its current state in order to define appropriate upgrades to the training products used in the Naval Aviation Survival Training Program (NASTP) curriculum and provide Commercial-Off-the-Shelf (COTS) system(s) recommendation to bridge identified gaps.

CAMP LEMONNIER, DJIBOUTI. A 303rd Expeditionary Rescue Squadron HH-60 Pave Hawk practices brownout landings near Camp Lemonnier, Djibouti, March 22, 2014. Brownout occurs when the rotor wash causes dirt, dust or sand to become airborne which can cause the crew to lose sight of the ground. (U.S. Air Force photo by Staff Sgt. Staci Miller/RELEASED).

PROJECT DURATION

JAN 2019 - SEP 2021

SPONSORS

US Army Medical Research and Development Command

POINTS OF CONTACT

Beth Atkinson (PI)
Gabriella Severe-Valsaint (Co-PI)
Dr. Melissa Walwanis (PM)
ORLO_PDRT@navy.mil

DESCRIPTION

In the Naval community, Spatial Disorientation (SD) and Situational Awareness (SA) are significant contributing factors to the majority of aviation mishap events. The Navy spends millions of dollars on safety training every year to educate aviation personnel of the warning signs to SD and loss of situational awareness (SA), but the training lacks customizable visualizations of actual SD and SA events. Maintained at the Naval Survival Training Institute (NSTI), SD curriculum is PowerPoint-based lectures intended to introduce and expose trainees to various types of SD that can be experienced in the aviation domain. This effort seeks to leverage advances in virtual reality and modeling and simulation for COTS recommendations that would enhance current SD and SA training by allowing users to set scenarios based on mishap data to recreate SD and/or SA events. The end product would provide trainees with a better understanding of the warning signs as well as strategies to mitigate SD and loss of SA for more impactful training.

NEED

Gaps were identified in the resources and expertise needed to conduct a transfer of training analysis for all SD and SA training to recommend updates to ensure learning objectives are met. This need was identified by the NASTP Trainer Management Team (TMT), in a point paper by the Officer in Charge (OIC) of NSTI. A Training System Requirements Analysis (TSRA) conducted by the Naval Air Warfare Center Training Systems Division (NAWCTSD) indicates that the very nature of how SD training is delivered to trainees needs to be updated to achieve training objectives.

BENEFITS

Results from this effort will identify a variety of training mediums available to support SD training, outline learning objectives that can benefit from these technologies, and provide results from the evaluation of identified system(s) ability to support SD training. These outcomes will help revamp the way SD is currently trained by injecting more realism and real-world experiences within the curriculum.

STATUS

In FY 21, the SD training technology matrix was finalized and one system was selected for the training evaluation. Different modalities of the system were assessed for their training effectiveness. An experimental protocol was developed and approved. Data collection was executed and analyses were conducted. Results were summarized in a report as well as recommendations for future training emphases.

MILESTONES

- Q4 FY19: Conduct kickoff meeting to set initial planning strategy
- Q2 - Q3 FY20: Evaluate existing SD training procedures and curriculum via site visits, demonstrations, and interviews
- Q3 - Q4 FY20: Conduct a detailed market analysis of existing SD training solutions and develop a training technology matrix for SD illusions to identify appropriate COTS products to supplement training
- Q1 FY21: Submit experimental protocol and receive IRB approval
- Q2 FY21: Present a poster at the U.S. Naval Aeromedical Conference
- Q2 - Q4 FY21: Collect and analyze training effectiveness data
- Q4 FY21: Summarize results in a report

Evaluating and Improving the Naval Aviation Survival Training Program:
Initial Operational Evaluation & Upgrade for the Normobaric Hypoxia Trainer (9A19)

OBJECTIVE

To conduct an effectiveness study to analyze current physiological hazards curriculum, specifically hypoxia training, to identify gaps and provide technological enhancements to the newly acquired Normobaric Hypoxia Trainer (NHT).

Testing of Hypoxia Training Application (HAT) software within the Device 9A19 Normobaric Hypoxia Trainer (NHT) with instructor personnel at the Aviation

PROJECT DURATION

APR 2019 - SEP 2021

SPONSORS

US Army Medical Research and Development Command

POINTS OF CONTACT

Beth Atkinson (PI)
Dr. Mitchell Tindall (Co-PI)
Dr. Melissa Walwanis (PM)
ORLO_PDRT@navy.mil

DESCRIPTION

Currently, the Naval Aviation Survival Training Program (NASTP) is transitioning from the hypobaric chamber to the Normobaric Hypoxia Trainer (NHT) for physiological hazards training. The NHT is designed to safely expose aircrew and aviators to a high-altitude, low-oxygen aircraft environment. Training scenarios involve instructors monitoring trainees as they complete a series of operationally relevant tasks on computer tablets/simulator within the NHT while the atmospheric equivalent altitude slowly increases to 25,000 feet. Performance is then assessed and outcomes from training will assist aircrew in recognizing symptom indicators, completing proper procedures to alleviate symptoms, and efficiently performing emergency procedures using actual aircraft life support equipment in order to prevent hypoxia-related mishaps.

NEED

As part of the current installation plan, each NHT will be delivered with six tablet computers for training six aircrew positions. However, the tablets will not include simulation/software-based domain-relevant tasks. This gap results in no cognitive or psychomotor tasking for aircrew during training that has been identified by the NASTP Trainer Management Team (TMT). Additionally, developmental testing of the NHT at Aviation Survival Training Center (ASTC) in Jacksonville has revealed opportunities to improve situation awareness (SA) by upgrading the COMNET software control and the instructor/operator (IO) stations. These identified upgrades will enhance trainee safety, improve trainee throughput, and increase training effectiveness.

BENEFITS

Through this effort, NHT will receive technology enhancements for both instructor and trainee that directly impact the NASTP curriculum, translating to increased readiness, improved warfighter performance, and increased survivability.

STATUS

We completed the design and development of distractor task. Mock-ups completed for Instructor Operating Station (IOS) graphical user interface (GUI) were revised. Installation of the IOS GUI software and Distractor Tasking Application was completed in SEP 2020. Iterative usability feedback has been collected SEP to NOV 2020 to inform final software delivery. In FY21, additional usability feedback and testing was conducted with Naval Survival Training Institute (NSTI) and Aviation Survival Training Center (ASTC) personnel to finalize the software build. Coordination with the Naval Aviation Survival Training Program is in the final stages to complete cybersecurity testing and integration into configuration management systems to allow for installation of the software at all eight ASTCs.

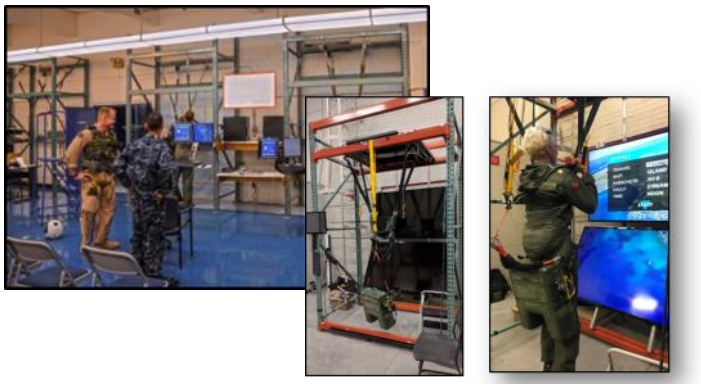
MILESTONES

- Performed formative and summative evaluations of the aircrew training task in FY20
- Iterated development of the aircrew distractor tasking software, delivering versions to the NAS Jacksonville ASTC and NAS Pensacola ASTC for testing
- Performed formative and summative evaluations of the IOS GUI in FY20
- Completed development and installation of IOS version 2.0 to the NAS Jacksonville ASTC (SEP 2020)
- Identified and documented areas to advance software for communication architecture and IOS, developing a backlog for future development considerations
- Delivered software build to NSTI and NASTP to support final transition planning

VIRTUAL REALITY (VR) PARACHUTE DESCENT TRAINER (PDT) (DEVICE 9C4/9C4A) EVALUATION

OBJECTIVE

To complete a comparative training effectiveness study between the current VRPDT to contemporary Commercial Off-the-Shelf (COTS) systems. This effort will help determine if upgrades to the existing system are capable of closing existing gaps or if a COTS solution is capable of providing aviators training on DPs, malfunctions and decision-making with the requisite training quality and effectiveness, supportability, and training realism.



Current virtual reality based parachute trainer and proposed next generation parachute training solution.

PROJECT DURATION

JAN 2019 - MAR 2022

SPONSORS

US Army Medical Research and Development Com-mandPMA-205 Air Warfare Training Development

POINTS OF CONTACT

Beth Atkinson (PI)
John Hodak (PM)
ORLO_PDRT@navy.mil

DESCRIPTION

In the Naval community, aviation survival training is an important focus area. The Naval Aviation Survival Training Program (NASTP) uses the VRPDT to conduct initial and refresher training for all aircrew designated to fly in parachute-equipped, fixed-wing aircraft. The VRPDT is an immersive training device with embedded parachute descent scenarios, which allows students to practice procedures to get safely from the aircraft to the ground, reinforcing what is learned in the classroom. Additionally, the simulation can present parachute canopy malfunctions, which students must correctly identify in order to perform the corrective procedures.

NEED

The current configuration of the VRPDT does not support F-35, which is needed at multiple Aviation Survival Training Centers (ASTC). Additionally, other type/model/series (T/M/S) aircraft may not be adequately represented. This gap has been identified by the Naval Survival Training Institute (NSTI) and the Trainer Management Team (TMT). Physically, the VRPDT has numerous problems due to the system's inability to interface with standard flight and parachute equipment across all T/M/S of aircraft. Also, being based on 25-year-old technology, the limited field of view (FOV) of the head-mounted display (HMD) system reduces the quality and effectiveness of training. Further, the dated display, graphics capabilities, and equipment configurations do not provide the appropriate level of physical and environmental fidelity to train all required tasks. Therefore, there is a need to compare the current system to modern, commercially available solutions capable of closing the gaps listed above.

BENEFITS

The results from this effort will be used to determine if a COTS solution is capable of closing the gaps identified by the TMT and inform acquisition decisions of parachute decent training systems for all eight ASTCs.

STATUS

The initial effort kicked off in FY19. Market research analysis identified available commercial off the shelf training solutions compared to the legacy and Small Business Innovation Research prototypes. A Cognitive Task Analysis (CTA) identified core Knowledge, Skills, and Abilities necessary for parachute training that focuses on malfunction correction, emergency procedures, and decision-making. A comparative effectiveness evaluation was conducted to compare virtual reality headset based systems compared to display based technologies to evaluate feasibility and cost effectiveness between systems. FY21 efforts focused on defining a research design to evaluate individual field of regard for impacts to field of view requirements of final system design. A study to understand if field of regard limitations result in changes in individual performance will be completed in FY22.

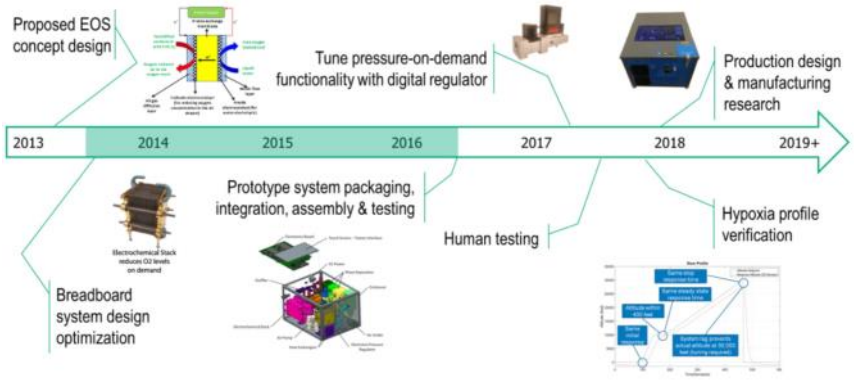
MILESTONES

- Evaluated existing parachute decent training procedures and curriculum and compare to CTA findings to refine learning objectives and training concepts
- Conducted a detailed review of available parachute training technologies to inform a market research analysis; presented finding to stakeholders at relevant conference
- Documented experimental design and in process of IRB protocol review for approval
- Comparative training effectiveness research study between two systems completed in FY21
- Findings presented at conferences and manuscripts under development for peer-reviewed journals throughout FY22-23
- IRB for field of regard study in preparation in collaboration with ERAU for study completion

MASK-ON HYPOXIA TRAINING DEVICE (N132-093)

OBJECTIVE

The effort seeks to support the technology transition of a next-generation hypoxia-training device under development as part of NAVAIR SBIR N132-093. The goals of this research include analysis of logistical concerns, human factors evaluations, and human testing to validate the fidelity and effectiveness.



Development timeline of an On-Demand Hypoxia Trainer based on research and development conducted under SBIR Phase I, Phase II and Phase II.5 efforts.

PROJECT DURATION

NOV 2013 - SEP 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)
Naval Aviation Training Systems Program Office, PMA-205

POINTS OF CONTACT

Beth Atkinson (TPOC)
John Hodak (PM)
ORLO_PDRT@navy.mil

DESCRIPTION

This effort will conduct the research and development (R&D) efforts necessary for validating the fidelity, safety, and concept of operations (CONOPS) of the On-Demand Hypoxia Training Device under development for transition to PMA-205. In addition to the required research, we intend to conduct separate independent tests and evaluations to document the performance parameters and benefits of the novel technology for existing and potential acquisition communities. Specific tasks include: research and analysis of logistic requirements for training technology; conduct Human Factors Evaluation of the instructor console; conduct human testing with a military aviator population; and validation of training system.

NEED

As hypoxia continues to remain a highly visible safety issue, focus on a range of potential mitigation solutions is imperative. While a variety of engineering solutions aimed at the aircraft are being considered and tested, the final line of defense will remain in the hands of our trainers.

BENEFITS

The acknowledged success of hypoxia training makes it paramount that the Navy ensures these capabilities remain available. In addition to providing a means for addressing the larger Navy research into mitigating hypoxia physiological episodes, this effort will advance the lab's understanding of hypoxia training. Through usability analyses, researchers will document ways to increase the ease of use of the instructional capability. Further, this effort will provide the means to thoroughly investigate a novel technology to determine the effectiveness and efficiency of the devices to deliver higher-fidelity training opportunities.

STATUS

Phase II efforts have resulted in a refined system prototype, human research, maintenance and sustainment analysis, as well as refining processes via research for manufacturing, reliability, and sustainability of the system. A procurement contract for approximately 40 units that will be delivered to the eight Aviation Survival Training Centers (ASTCs) through FY22 was awarded in FY21. Initial delivery of units to ASTC Jacksonville took place in OCT 2021. Efforts are underway to expand the system.

MILESTONES

- Phase II/II.5 Efforts
  - ◊ Signed Technology Transition Agreement with PMA-205
  - ◊ Fleet engineering testing conducted to refine pressure on demand capability
  - ◊ Iterative usability testing of system and endurance and reliability testing in process
  - ◊ Refined prototype developed to support engineering and human testing
  - ◊ Fleet engineering testing conducted to refine pressure on demand capability
  - ◊ Preliminary device documentation and drawings delivered

PROJECT AVENGER EVALUATION

OBJECTIVE

Evaluate the training effectiveness of Project Avenger, the Primary Fixed-Wing Syllabus component of Naval Aviation Training Next (NATN). The evaluation will provide data on student naval aviator (SNA) performance and time to train, as well as recommended improvements for future iterations of Project Avenger.

T-6B Virtual Reality Device Usage

PROJECT DURATION

SEP 2020 - DEC 2021

SPONSOR

Naval Aviation Training Systems Program Office, PMA-205

POINTS OF CONTACT

Dr. Ada D. Mishler (PI)
Gabriella Severe-Valsaint, M.S. (Co-PI)
LT. Michael W. Natali, MSC, USN, Ph.D. (PM)
Jeffrey Llewellyn (PM)
ORLO_PDRT@navy.mil

DESCRIPTION

As a part of NATN, Chief of Naval Air Training (CNATRA) has developed and begun to implement Project Avenger, an update to their Primary Fixed-Wing Syllabus that leverages an adaptive syllabus, extended reality, and mobile learning to address Strike/ Fighter production challenges. Project Avenger is intended to produce more self-sufficient pilots while also reducing time to train. The research team will compare the performance of Project Avenger's student naval aviators (SNAs) to that of SNAs in legacy training, as well as collect SNA and instructor pilot (IP) reactions to provide success metrics and improvement recommendations for Project Avenger.

NEED

- Naval Aviation Simulation Master Plan IV Priority 5: refine strategy to "provide a basis of understanding the potential for leveraging technology to solve training challenges"
- PMA-205 Strategic Initiative: Investigate the utility of Virtual and Augmented Reality

BENEFITS

CNATRA intends to expand Project Avenger to replace all legacy-style Primary training in the next few years. This evaluation will produce training effectiveness data to identify successes and areas for improvement of Project Avenger. In doing so, it will help CNATRA maximize training efficiency and performance outcomes, leading to increased training pipeline throughput and mission effectiveness. It will also inform best practices for future development of aviation training syllabi.

STATUS

In FY21, evaluation plans were delivered to CNATRA for approval and a kick-off teleconference was held to finalize research design and identify subject matter experts to support the effort. Comparison events in Project Avenger and the legacy syllabus were identified. Avenger SNAs completed Primary Training and CNATRA provided performance data for both Avenger and legacy SNAs as well as qualitative data on the new approach for analysis. Performance data were analyzed and a summary of the findings was submitted in a technical report.

MILESTONES

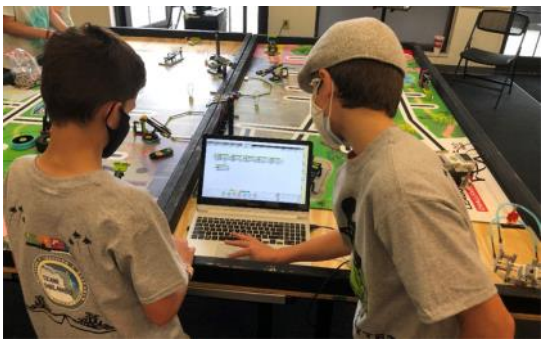
- SEP 2020 - MAY 2021: Data collection of first class of Project Avenger SNAs began (n = 20)
- OCT 2020: Kick-off teleconference with primary training and Project Avenger leadership
- NOV 2020: IRB Protocol approved
- APR 2021: Focus group with Avenger IPs and leadership
- MAY - AUG 2021: Analysis of performance and SNA feedback data
- JUL - OCT 2021: Technical report writing and submission to PMA-205

NAWCTSD/TEAM ORLANDO STEM OUTREACH

GEMS Camper, Isabella Salva (17), learns how to perform landing signals on a simulated aircraft carrier during GEMS STEM Camp, July 2021. Source: Emily Sherkow

NAWCTSD and Team Orlando conduct STEM outreach to support three Department of Navy STEM missions and goals: to inspire, engage, and educate the next generation of scientists and engineers, technology professionals, and medical professionals; to employ, retain, and develop diverse civilian and military technical workforce; and to collaborate across the Naval STEM communities and with other agencies to maximize benefits to the DoN.

NAWCTSD and TEAM ORLANDO organizations collaborate to support a variety of STEM outreach engagements that serve the Central Florida community. Supported by a dedicated team of employee volunteers, our Command is able to perform an impressive array of individualized outreach activities to students of all ages, including post-secondary level. Of exceptional note is the recent establishment of DoD STARBASE Central Florida!



NAWCTSD & Team Orlando's own Gatorbytes robotics team members, Connor Rivera (11) and Isaac Sherkow (12), program their robot to perform missions during a FIRST LEGO League regional qualifier competition in April 2021. Source: Asher Sherkow

The U.S. is behind the curve when it comes to graduating a strong, well-trained workforce competitive with other countries. Early STEM education and skills are essential to developing talent to meet the needs of emerging technologies, products, and services in the modeling, simulation, training and other high tech industries supporting Department of Defense.

The Gatorbytes pose during a FIRST LEGO League regional qualifier competition, April 2021. Pictured left to right, Asher Sherkow, Connor Rivera (11), Trent Roth (11), Isaac Sherkow (12), and Luis Rivera. Source: Asher Sherkow

FY20 NAVY LOCAL IMPACT AT A GLANCE	
STEM Program Launched	2009
Geographic Reach	Brevard County Orange County Osceola County Seminole County Volusia County
Employee Participation	1 part-time site coordinator 78 Employees 15 mentors (robotics and Blankner)
Interactions	3,963 Teachers 12,775 Students

- Establishment of DOD STARBASE CENTRAL FLORIDA STEM ACADEMY!: OSD Approval APR 2021; Contract Awarded SEPT 2021; Classes begin JAN 2022. Students will begin exposure to STEM education with STARBASE, entering the DoD STEM pipeline and progressing through GEMS camp, GEMS internships, NREIP internships, and eventually employment at NAWCTSD.
- GEMS STEM CAMPS: Four week-long sessions during FY21; over 125 students, grades 7-9, learned to build their own drones and program missions for competition; students learned about careers in MS&T and other STEM fields
- Robotics Grants Awarded by OSD to 90 different FIRST LEGO League Robotics teams, serving roughly 875 students across 4 Central Florida Counties
- New/Renewal of three Educational Partnership Agreements: Seminole, Orange, and Duval County Public School Districts; expecting additional EPAs with Volusia and Hillsboro by end of FY22.
- Four Navy-sponsored STEM Teacher Training Workshops: "Math With Robots" and "Introduction to Arduinos;" serving 75 public school teachers across three Central Florida districts, directly impacting over 1,875 students, with indirect impact to thousands more through loaning class kits and faculty-led Train-The-Trainer (TTT) events.
- July 2021 Tech Grove Filed Trip for OCPS Artificial Intelligence (AI) Summer Camp High School Students - guest speakers included Mr. Johann Soto (NAWCAD AI Lead), several NAWCTSD NERDS Lab scientists, and Robotics Outreach Lead volunteer, Mr. Asher Sherkow
- NAWCTSD & Team Orlando robotics team, The Gatorbytes, compete in regional qualifier robotics competitions. A second team, The Simulators, is being established.
- Virtual STEM outreach programming conducted throughout the year, including Orlando Navy Week, and livestreamed webinar, "Women in Navy STEM," highlighting leadership and career journeys of active duty and civilian Navy personnel across four different Navy installations.

FLIGHT LAB AFTERSCHOOL

OBJECTIVE

The goal of this effort is to support the Office of Naval Research (ONR)'s mission of fostering STEM education for students. Through the Flight Lab at the Orlando Science Center (OSC), an aviation simulation classroom, students are able to engage with hands-on, immersive, USMC/Navy-specific, STEM-related content via afterschool programs. By reinforcing STEM learning through experiences that model real-world careers, we endeavor to inspire future generations to explore STEM careers—especially STEM careers within aviation in the Navy and USMC.

Above left. Entrance to the Flight Lab at OSC
Above right. Students enjoying the Flight Lab
Left. Inside of the Flight lab at OSC

PROJECT DURATION
JAN 2019 - AUG 2021

SPONSORS
Office of Naval Research, ONR-34

POINTS OF CONTACT
Natalie Steinhauser (PI)
Emily Sherkow
ORLO_PDRT@navy.mil

DESCRIPTION

The Flight Lab Afterschool program uses the TEQGames-developed Flexible Aviation Classroom Experience (FLEX-ACE), within the OSC's Flight Lab, to teach students Science, Technology, Engineering, and Mathematics (STEM) concepts via an immersive, aviation-centered virtual reality (VR) laboratory. The program focuses on underserved audiences, including girls in STEM, and includes four 9-week cohorts recruited from afterschool clubs in the greater Orlando Metro area. These students engage with the aviation-themed immersive content nine times over a semester. The program effectiveness is assessed via pre- and post-test performance on aviation-specific and general STEM knowledge, as well as simulated flight performance.

NEED

It is essential for the USMC and Navy to maintain recruitment of top STEM talent, as STEM fields are critical to the effective training and performance of the Warfighter. However, many adolescents lose interest in STEM early in their academic careers—sometimes as early as the 3rd grade. Thus, there is a need to provide meaningful educational opportunities for youth to experience STEM "beyond the textbook." It is imperative to get children engaged in STEM in interactive ways—hence, the immersive, game-based learning environment offered by FLEX-ACE.

BENEFITS

- Support the DoD and ONR's mission of fostering K-12 STEM education.
- Engage 5th-12th grade students with hands-on, immersive USMC/Navy aviation experiences.
- Inspire and motivate the next generation to explore STEM careers.
- Provide opportunities for evaluation and assessment of the impact of immersive STEM programs on students and the community.

STATUS

Fall 2019 consisted of four 9-week cohorts, with ~19 – 25 students per group, who participated in nine ~45 – 60 minute visits over the semester. Missions included simulated flights a) around Washington, D.C. to identify historical landmarks; b) over Alaska to drop medical supplies to targeted locations; and, several other engaging scenarios. The learning and flight performance assessments for Fall 2019 ended in early JAN 2020. Analyses of the pre- and post-test data (for the 27 students who completed both) revealed a learning gain of ~21% (standard deviation = 26%). Results also showed modest improvements in student flight performance. All planned afterschool workshops for 2020 were cancelled due to the pandemic. However, the effort will be continuing in JAN 2021 as a "virtual field trip" experience.

MILESTONES

- April 2019 – Program Kick-off with ONR
- Aug 2019 – Finalized missions (8 new aviation missions developed) and assessment materials; completed participant out-reach/recruitment efforts
- Dec 2019 – Presented overview of effort at IITSEC "CYBER TRAINsitions" Workshop
- Jan 2020 – Completed all Fall 2019 Cohort sessions and assessments with a total of 285 student participants
- Jan 2020 – Analyzed learning gains and flight performance improvement data from Fall 2019 Cohorts
- Feb & Sep 2020 – Provided project status presentation at ONR Technical Review meetings

STEM SEXTANT

OBJECTIVE

This effort will develop a mixed reality (MR) application to enable students to learn and practice celestial navigation skills using a sextant in an immersive, three-dimensional (3D) environment. Additionally, the team aims to provide designs, specifications, and instructions for building a sextant, giving students the opportunity to develop engineering skills including 3D printing and sensor wiring.

Mark 3 Sextant, Arduino Uno with breadboard. Photo Credit: Eric Peterson

PROJECT DURATION

AUG 2020 - MAR 2021

SPONSOR

Office of Naval Research

POINTS OF CONTACT

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Eric Peterson (Co-PI)
Emily Sherkow (PM)
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DESCRIPTION

Students will practice STEM skills by building a mixed reality (MR) sextant that will connect to a virtual reality (VR) application built by a NAWCTSD development team. This application will teach teams how to perform celestial navigation through practice exercises, visualizations, and game features.

Computer-Aided Design (CAD) models for printing the sextant and code for programming the microcontroller will also be provided. Educators leading the event can customize the experience to meet the skill levels of student participants by allowing teams to generate their own CAD or program the microcontroller themselves.

Several studies are planned over the duration of the project, including assessments of student satisfaction, perceived usability, interest in STEM topics and careers, and training effectiveness.

NEED

Celestial navigation is being taught by the Navy again after being dropped from the curriculum in the 1990s. In the event of Global Positioning System (GPS) failure or denial of GPS attacks, sailors need to be able to navigate accurately using celestial bodies.

BENEFITS

Students will learn how the Navy uses celestial navigation to mitigate threats to the Fleet. As this subject is one many sailors struggle with, there is potential to transition the application to a Fleet-funded training product.

STATUS

The team is currently in the process of designing the electronics for the virtual sextant and creating the virtual environment in which the celestial navigation training will take place. A pilot event is planned for the second quarter of FY21.

MILESTONES

- Develop virtual world in Unity game engine
- Design and develop sextant mock-up and integrate into virtual world
- Add instruction, hints, and feedback
- Work with local high school to validate effectiveness of training and accuracy of sextant design documents

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LABORATORY CAPABILITIES

At the Naval Air Warfare Center Training Systems Division (NAWCTSD), we have many laboratories engaged in research and development. These labs work to advance the state-of-the-art in training technologies in human factors, human-machine interfaces, augmented reality (AR) and virtual reality (VR), data analysis, acoustics and sensors, visual systems, data analysis, fabrication, interoperability, Live, Virtual, Constructive (LVC) applications and technologies, communications, and more. The following section provides summaries of the capabilities and expertise in the labs.

Acoustic Training and Simulation (ATaS) Lab

MISSION

Provide current sensor and acoustic data used in modeling and simulation across Navy Anti-Submarine Warfare training devices.

EXPERTISE

- Navy Subject Matter Experts –

  Anti-Submarine Warfare, Underwater acoustic analysis
- Systems Engineer –

  Configuration Management

POINTS OF CONTACT

John Tabor, Lab Lead
Hoang Doan (HD), Lab Manager

ORLO_PDRT@navy.mil

CAPABILITIES

- SME support with Real-Time Acoustic Training System Tuning
- Development and Sustainment of Acoustic Databases
- Data updates based on dynamics of ONI sources
- Database Distribution
- Target Tuning
- NCTE ASW database standard
- Update and provide appropriate databases for Foreign Military Sales (FMS) of Aviation and Surface Ship ASW/Acoustic Trainers.

PRODUCTS & TOOLS

- The **ATAS Database** contains detailed data on Contacts (ships, submarines, torpedoes, and biologicals) using over 100 tables.
- The **Common Sensor Database (CSDB)** contains detailed data on Sensors (DICASS, DIFAR, MAC, and Towed Array) using over 150 tables.
- **The Active Emitter (AE) Database** contains detailed data on active sonars for contacts and sensors using over 40 tables.
- **Digitized Sounds** provide audio for Contacts and Sensors
- **CASE FI Single Node** Acoustic processor used to adjust fidelity of acoustic contacts prior to fleet delivery

BATTLE LAB

Basic & Applied Training & Technology for Learning & Evaluation Lab

CAPABILITIES

- **Human Performance Analytics Research, Development & Implementation** including individual and team performance, performance measurement authoring tools, databases for performance trend analysis and data analytics, computational techniques for evolving data for trend identification and predictive analytics, tools for evaluating data re-use to enhance training scenarios and performance assessments, proficiency analysis tools to facilitate debriefing solutions, and standards for increasing interoperability of human performance analysis.
- **Synthetic Environments Research, Development & Implementation** including standards support and interoperability mission effectiveness analyses, researching cross domain management tools, integrated behavior modeling and speech analysis for synthetic teammates, skill adjustments for automated behavior modeling, speech recognition support tools, and extended reality (e.g., VR, AR, MR).
- **Instructional Strategies & Methods for Team Training** including digital integrated representation of the tactical environment, tailored training and assessments, decision making training strategies, learning management systems, resilience training strategies and methods, and adaptive training.
- **Aviation Survival Training Research, Development & Implementation** including hypoxia and dynamic breathing threat training enhancements, parachute descent procedure and malfunction training, and mishap and spatial disorientation training.
- **Instructional Technology Improvements** including next generation manned-unmanned teaming concepts, data science driven aircrew performance measurement and proficiency tools for debriefing and evaluation, machine learning support for malfunction troubleshooting, workload assessment.
- **Aircrew & Maintenance Training Systems Improvements & Evaluation** including development of training technology for oceanography tactics training, maritime intelligence-surveillance-reconnaissance training, physiological episode distractor application, and communication training, as well as front end analyses and training effectiveness evaluations of training prototypes and tools.

TOOLS

- Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA)
- CNATRA T-6B Virtual Instructor Pilot Exercise Referee (VIPER®) Evaluation
- Techniques to Adjust Computational Trends Involving Changing Data (TACTIC-D)
- Oceanography Tactics Training for Employment Readiness (OTTER)
- Radio Operations Guidance and Education Resource (ROGER)
- Mask On Breathing Device (MOBD) for Dynamic Breathing Threats
- Operational Partner To Interactively Manage Uninhabited System Procedures & Responses In Multi-Emergencies (OPTIMUS PRIME)
- Immersive Emergency Procedure Parachute Training

MISSION

Conduct and manage science and technology (S&T), research and development (R&D), transition and acquisition consultation efforts through the application of cognitive science, behavioral research and training evaluations to improve training and human performance in a variety of learning environments.

EXPERTISE

- Human Performance Analytics Research, Development & Implementation
- Synthetic & Immersive Environments Research, Development & Implementation
- Instructional Strategies & Methods for Team Training
- Aviation Survival Training Research, Development & Implementation
- Instructional Technology Improvements
- Aircrew & Maintenance Training Systems Improvements
- Autonomous & Manned-Unmanned Teaming Research for Operational & Training Technologies
- Training Effectiveness & Technology Capability Evaluations

POINTS OF CONTACT

Beth Atkinson, Lab Lead
Rosemary Garris, Lab Manager

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Concept Development & Integration Lab (CDIL)

MISSION

Research and Development of specialized, interoperable Live-Virtual -Constructive applications and technologies; provide smart buyer awareness to training system acquisition programs.

EXPERTISE

- Live—Virtual Communications
- Live & Virtual Radio Management
- RF Communications Modeling
- TEMPEST Certification
- After Action Review (AAR) applications
- Rapid Prototyping (Software & Hardware)
- Embedded Systems Development
- System Interoperability
- Modeling & Simulation Standards

POINTS OF CONTACT

Al Peluso, Lab Lead
Jesse Gusse, Lab Manager

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CAPABILITIES

Electronic Communications Subject Matter Expertise:
Voice Communications (Analog & Digital);
Live-Virtual-Constructive Interoperability;
RF Propagation / Terrain Modeling

Cyberwarfare Training:
Realistic emulation of Network and Host based Cyberspace attacks;
Cyber Red Zone Capture the Flag

Rapid Prototyping / Proof of Principle Development:
Requirements -> First Article Test;
System Interoperability; DoD Standardization

Software Development

Hardware / Electronic Design & Fabrication

TEMPEST Separation & Certification

Technology Research:
RF Communications; Modeling & Simulation;
Cyberwarfare Training

Acquisition Support:
Technical Consulting / Market Surveillance / Documentation Review

TOOLS

- Windows, Linux & Embedded Development Environments
- Altium Designer
- Atmel Studio (micro-controllers)
- Microsoft Visual Studio / IntelliJ
- Solidworks

Interoperability, Design, Engineering, and Application (IDEA) Lab

CAPABILITIES

- **Interoperability Test and Integration Tools** enabling automated testing, logging and stimulation of training systems.
- **Simulation Bridge and Gateway** products to translate between differing standards and other simulation standards/protocols.
- **Virtual and Constructive Test and Integration Support** verifying training system interoperability and an active test bed for research.
- **Controlled Interface (CI)** development and sustainment to support distributed mission training.
- **Out-The-Window (OTW) visual, sensor, terrain, and 3-D model databases** to provide maximum source data reuse across training devices for various Type/Model/ Series platforms.

TOOLS

- Network connections to the Navy Continuous Training Environment (NCTE) NETTN, NMCI SIPR and NIPR
- Visual Studio, C++, NetBeans, Java, SVN, Git, Jira, Confluence, Fortify, Jenkins
- 180 degree visual display with four DLP Projectors
- 4 Channel PC based Image Generator (IG) & Video Switch

MISSION

Support research, development, test and evaluation of training systems interoperability. The lab provides tools for visual systems analysis, database development, system integration and command demonstrations.

EXPERTISE

- Training Systems Integration
- Controlled Interface (CI) Solutions for Training Systems
- Training Systems Interoperability Standards
- Simulation Test and Integration
- Simulation Protocol Test Tools
- Agile Software Development

POINTS OF CONTACT

Brett Trantham, Lab Lead
Troy Bennett, Lab Manager

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LVC Development and Operations Center (LVCDOC)

MISSION

The LVCDOC is a network centric environment that provides a reconfigurable, dynamic LVC integration domain supporting Research and Development (R&D) and Test and Evaluation (T&E) of new technologies and methods, and encouraging collaboration among LVC stakeholders.

EXPERTISE

- Modeling and Simulation
- Virtualized Network Environments
- Hardware/Software Integration
- System-of-Systems Interoperability
- Cross Domain Solutions
- Multi-Level Security
- Tactical Voice Transport
- Cyber Effects
- After Action Review
- Computer Science & Engineering
- Information Assurance

POINTS OF CONTACT

Lance Legan, Lab Lead
Sean Worrell, Lab Manager

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CAPABILITIES

- **Network centric environment** created to be persistent and rapidly reconfigurable, supporting Research and Development (R&D) and Test and Evaluation (T&E) for LVC initiatives across all Navy platforms including aviation, surface, and undersea, in partnership with other Government organizations, Industry stakeholders, and academic institutions.
- **Interoperability Assessment and Validation** across all stages of the System Engineering Integration and Test process as a measure to accelerate LVC technology development and reduce risk.
- **Conduct technology test and integration preparation events** to improve the quality and speed of integrating new M&S capabilities into Distributed Mission Training (DMT) events.
- **Classified, Unclassified or Mixed Mode Operation**

TOOLS

- **Distributed Simulation Standards (HLA, DIS, TENA)**
- **Protocol Conversion (JBUS & AMIE)**
- **Constructive Simulations (NGTS, JSAF, & OneSAF)**
- **Joint After Action Review (JAAR)**
- **Cyber Effects (Network Effects Emulation System (NE2S))**
- **Command and Control (C2PC)**
- **Network Monitoring/Analysis (WAN Emulation)**
- **Cross Domain Solution/Multi-Level Security (Enterprise Network Guard (ENG))**

Live, Virtual, Constructive, Modeling & Simulation (LVCMS) Lab

CAPABILITIES

The LVCMS Lab capabilities include the development of computer software, including computer system architecture and system software organization for Live, Virtual, and Constructive Modeling and Simulation Trainers, specializing in Anti-submarine Warfare and Virtual At-Sea Training Systems.

- **Bravo Air Crew Tactical Team Trainer (BATTT)** The Anti-Submarine Warfare (ASW) Virtual-at-Sea Training (VAST) Bravo Acoustic Tactical Team Trainer (BATTT) system is a networked, PC-based, deployable trainer designed to support integrated and coordinated ASW tactical training and enhance team decision making
- **Romeo Air Crew Tactical Team Trainer (RATTT)** is a networked, PC-based, deployable trainer designed to support integrated and coordinated ASW tactical training and enhance team decision making
- **P-3 Air Crew Tactical Team Trainer (PACT3)** provides the first ever PC-based (small foot-print, low cost) training capability for currently fielded P-3 Maritime Patrol Aircraft that can be reused with very minor flight dynamics model modifications to represent the Navy's future P-8A Maritime Patrol Aircraft, allowing cross platform (Aviation, Surface, Undersea) coordinated ASW integrated team training.
- **Bravo Romeo Acoustic Stimulation System (BRASS):** BRASS for Sea Combat Commander (SCC) is a NAWCTSD effort for providing the Anti-Submarine Warfare (ASW) characteristics of the MH-60R Helicopter Platform stimulating the Aircraft Carrier Tactical Support Center (CV-TSC) using the SAU07000 message standard.
- **Mine Countermeasures Aircrew Training System (MCATS)** The AN/AQS-24B Sonar Mine Detecting Set is a high-speed, high-resolution sonar system with the capability to implement a laser line scan (LLS) sub-section for the detection, classification and identification of mine-like objects.
- **Mission System Operational Readiness Trainer (MS-ORT)** is a high fidelity trainer developed for the USCG HC-130J and HC-144 aircrafts used to train extended-range, search and rescue (SAR), and combat search and rescue (CSAR) missions. MS-ORT models ADS-B, AIS. EGI, DF-500, EO/IR, radar, and comms which are fully integrated with the Minotaur Mission Systems.

TOOLS

- Passive Generator for realistic audio for passive sensors
- APModule used for realistic audio for active sensors
- DOG to provide environmental data for ocean modeling
- Visual Studio
- HLA Gateway

MISSION

Development of computer software, including computer system architecture and system software organization for Live, Virtual, and Constructive Modeling and Simulation Trainers, specializing in Anti-submarine Warfare and Virtual At-Sea Training Systems.

EXPERTISE

- Computer Scientists
- Computer Engineers
- Subject Matter Experts

POINTS OF CONTACT

Jacob Bourque, Lab Lead
Jesse Gusse, Lab Manager

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Multipurpose Reconfigurable Training System 3D® (MRTS 3D®) Lab

MISSION

To provide fully immersive training environments via a common architecture for low-cost, rapidly-deployable training solutions.

EXPERTISE

- Computer Scientists
- Computer Engineers
- Graphic Artists
- Subject Matter Experts

SUPPORTED SITES

- Groton, CT
- Guam
- Kings Bay, GA
- Norfolk, VA
- Portsmouth, NH
- Pearl Harbor, HI
- Pensacola, FL
- San Diego, CA
- Bangor, WA
- Point MUGU, CA

POINTS OF CONTACT

Harry Narvaez, Lab Lead
Kenneth Reams, Lab Manager

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CAPABILITIES

The Multipurpose Reconfigurable Training System 3D® (MRTS 3D®) family of trainers provide virtual training environments simulating a variety of platforms, weapons, and communications systems. Each trainer consists of government owned and developed simulation software running on a stand-alone network of Commercial-Off-the-Shelf (COTS) hardware and software components. A single MRTS hardware trainer can shift between multiple software simulation applications in a few minutes. This capability enables the school to use one hardware suite to give photo-realistic virtual training on several different systems in a single day.

The MRTS 3D trainers are used in both Sailor pipeline courses and in pre-deployment team training. The instructor can manage configurations and scenarios while the students follow procedures, interact with the touch screens, and coordinate with the other stations during the various training scenarios.

Fielded MRTS 3D Trainers

- VIRGINIA Torpedo Room
- 2015 VIRGINIA EDG
- 2016 MEPP Ops & T/S
- 2016/17 VIRGINIA VLS Block I/II/III
- 2018 FM EDG Ops & Maint.
- 2018 688 2nd Fight/688I TR
- 2019 Standardized IOS & SDK
- 2020 AEGIS MMSP Maintenance
- 2020 MQ-4C Triton Avionics Maint
- 2020 SLQ-32 Maintenance
- 2021 EMALS/AAG Ops & Maint

New Projects

- AAG
- JCC Radio Trainer
- USA HIMARS Vehicle Maintenance
- E-6B / E-6B MAST
- ETRT
- DDG-1000

Submarine Surface Piloting and Navigation Training Laboratory (NAVLAB)

CAPABILITIES

The lab utilizes an integrated development environment and modular test berth to perform trainer support functions:

- Software design and development from Fleet requirements to Fleet Acceptance, based on In-House Development Process (iDP) and In-House System Engineering Technical Review (iSETR).
- Immersive, mixed-reality environments for multiple submarine baselines
- Modeling and simulation of tactical systems
- Distributed system design using High Level Architecture (HLA) and TCP/IP network.
- Modeling and simulation of virtual harbor navigation
- Software integration and testing facility
- System Delivery and Upgrade with full technical and logistics support

The Submarine Piloting and Navigation (SPAN) Trainer

The SPAN trainer provides team and individual training in piloting and navigation principles of a surfaced submarine for the Helmsman, Fathometer Operator, Navigation Center Operator, Voyage Management Operator, Contact Coordinator, Periscope Operator, RADAR Operator, Officer of the Deck, and Lookout. The team uses navigation techniques and simulated on-board equipment to ensure the ship is safely piloted and navigated in various harbors, under variable environmental conditions.

Virtual Environment for Submarine Ship Handling (VESUB) Trainer

The VESUB trainer is a virtual reality-based computer system utilizing immersive Virtual Environment and Head Mounted Display (HMD) technology. The trainer consists of Commercial-Off-The-Shelf (COTS) hardware and software integrated with custom software as a system. It is comprised of an Instructor Operator Station, visual system, student station, voice recognition/synthesis system, audio system, and multiple screen displays. It provides the Officer Of the Deck (OOD) student individual instruction in the knowledge and skills necessary to successfully and safely pilot and maneuver a surfaced submarine through restricted harbors/waterways avoiding collisions and grounding.

TOOLS

- Microsoft Visual Studio, Team Foundation.
- HLA using MAK RTI/VR-Link
- GDIT VShip for hydro model

MISSION

Provide full trainer life cycle support for the SPAN/VESUB submarine navigation trainers of record including software/systems development, integration test, design, packaging, and fielded updates.

EXPERTISE

- Computer Engineers/Scientists
- Submarine Subject Matter Expert

DEPLOYMENT LOCATIONS

Trident Training Facility (TTF)

- Bangor, WA (SSBN/SSGN)
- Kings Bay, GA (SSBN/SSGN)

Submarine Learning Center (SLC)

- Groton, CT (SSBN/SSGN/Virginia/SSN 688/SSN 21)
- San Diego, CA (SSN 688)
- Norfolk, VA (Virginia)

POINTS OF CONTACT

Tim Cook, Lab Lead
Chad Farwig, Lab Manager

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Rapid Design, Development and Fabrication (RD2F) Laboratory

MISSION

Provide the Commander NAWCTSD with an in-house, rapid-response design, development and production capability for advanced modeling and simulation technology products.

EXPERTISE

- Modeling and Simulation
- Computer Science / Data Science
- Mixed Reality Systems
- Mobile Technology
- Rapid Design and Production
- Agile Software Development
- Electromechanical Systems
- Embedded Systems
- Hardware/Software Integration

POINTS OF CONTACT

Courtney McNamara, Lab Lead
Rocco Portoghese, Lab Manager

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CAPABILITIES

- **Turnkey Training System and Technology Design and Production** including proof of concepts, rapid prototypes, limited quantity productions and life-cycle extension upgrades.
- **Virtual Environment and Game-based Technologies** including simulation-based training system development, Augmented and Virtual Reality integration, interactive/immersive courseware, 3D terrain and content development, hand-held toolset/equipment integration with virtual environments and user experience design.
- **Enterprise Data Analysis, Modeling and Tool Creation** including enterprise-scale data mining and root cause analysis, AI-based predictive model creation and validation, statistical trend analysis, custom data engineering applications and enterprise data visualization.
- **Software Application Development** including cross platform mobile development, distributed and embedded applications, real-time embedded control, machine vision and intelligence, natural language processing, adaptive applications, intelligent agents, instructor support and after action review software.
- **Electronics Design and Fabrication** including circuit design, prototype and small-quantity circuit board production, wired and wireless interfaces, firmware development, device fabrication and assembly and production of electronic test equipment suites.
- **Mechanical Design and Fabrication** including part and assembly design, electro-mechanical and -optical devices, pneumatic systems, 3D modeling , virtual prototyping with 3D assemblies and fabrication using a variety of materials (plastics, non-ferrous metals, stainless steels). Additive and subtractive manufacturing process are supported for both prototype and low rate production.

TOOLS

- AAA game engines (Unity 3D, Unreal 4)
- Local high performance computing stack (14 PFLOPS Tensor Performance)
- Visual Studio, Team Foundation, Jira, Kubernetes, Spark, Keras, TensorFlow, Anaconda, Xamarin and others
- Computer Aided Design (CAD) and Manufacturing (CAM)
- Computer Numeric Control (CNC) machining
- Fused Deposition Modeling (FDM) and Polyjet plastic additive manufacturing

Ready Relevant Learning (RRL) Laboratory

CAPABILITIES

- Testing of course content for RRL and other programs at NAWCTSD via TRANET-U and TRANET-C Virtual Desktop Initiative (VDI).
- Testing of course content on mobile devices.
- Contractor VDI testing on TRANET-U and TRANET-C.
- Navy eLearning (NeL) content hosting.
- Static application security testing.

TOOLS

- TRANET Unclassified Network
- TRANET Classified Network
- NETC Virtual Desktop Installation (VDI)
- NeL Atlas Pro/Enterprise Training Management Delivery System (ETMDS)
- Government Content Acceptance Testing (GCAT) Environment
- NeL Content Hosting and Reports Management Service (CHaRMS)
- Micro Focus Fortify
- NETC Test Tool

MISSION

The Sailor 2025 Ready Relevant Learning (RRL) Lab supports the test and evaluation of training content and technologies in support of the goal to provide the right training at the right time in the right way for Sailors.

EXPERTISE

Test & Evaluation of:

- HTML 5 courseware
- Instructional Virtual Simulations
- Standalone courseware
- Mobile courseware

POINTS OF CONTACT

Jessica Sarratt, Lab Manager
Patricia Edmonds, Lab Lead

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Surface Training Advanced Virtual Environment (STAVE) Laboratory

MISSION

Support developmental systems, rapid configurability, special hardware and software requirements and sustainment of Littoral Combat Ship Training Systems.

EXPERTISE

- Information Technology
- Cyber Security
- System Engineering
- Software Integration
- Instructional Systems Design

POINTS OF CONTACT

Angel Ramos, Lab Lead
John Shaw, Lab Manager

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CAPABILITIES

The STAVE lab supports the Virtual Ship Training System (VSTS) a modular virtual training environment network infrastructure located at Littoral Combat Ship Training Facilities (LTF). The LTF VSTS supports individual, multiple, and team training for Seaframe and Mission Module Detachment (MMDET) crew to train to qualify (T2Q) watch stander and train to certify (T2C) team training requirements. The virtual environment is networked with all physical simulators for visualization, communications and systems operations to enable expanded individual and team training events. The STAVE Lab provides configuration management of the IVSE courseware, Virtual Ship Training Systems (VSTS) products and various trainers and training systems located at the LCS Training Facilities (LTFs).

Cybersecurity Support – The LCS Lab serves as the repository of updates and patches for the unconnected trainers (not only LCS). Utilizing synchronization of repository databases, the lab can scan for patches and updates and download those required for an unconnected trainer.

Prototyping – Training Equipment Change Requests (TECRs) can be prototyped and tested in the lab before deploying them in a production environment.

External Product Integration – The LCS Lab have utilized the baselined VSTS environment to integrate, setup, and test with external products, adding training capabilities to the LTFs.

Virtual Ship Training Systems (VSTS) – Provides Network Infrastructure Services, Sustainment, Cyber security, and Centralized Management of Training Systems.

STAVE-LCS IT – Information Technology training system that brings the LCS ship IT environment virtually to train Sailors on managing the IT systems of the ship.

Virtual Reality Laboratory (VRL) - Student and Instructor Station Hardware Platform that can support multiple training environments.

Immersive Virtual Shipboard Environment (IVSE) - Install and test Courseware into hardware platform. Integrate to VSTS and create baselines for distribution to LTF.

TOOLS

- Microsoft System Center Configuration Manager (SCCM)
- Virtualization Technologies
- Centralized Management Systems

STEALTH LAB
Science for Training, Evaluation, Analysis, Learning and Theory Lab

CAPABILITIES

Support for Design and Development of Training Programs and Instructional Tools

- Front End Analysis Tools/Techniques
- Cognitive Task Analyses for multi-teams and systems
- Job Task Analysis
- Personnel Selection
- Types of Feedback
- Adaptive Training
- Multi-culture Teams

Application of Advanced Technologies in Training Systems

- Live, Virtual, and Constructive (LVC)
- Augmented Reality
- Games and Gamification
- Multi-user Virtual Environments
- Virtual Worlds

Training Effectiveness Evaluations

Human Computer Interface Design

PROJECTS INCLUDE

- Live, Virtual, and Constructive (LVC)
- Multidisciplinary Extended Reality Team
- Investigation of Training Fidelity for Carrier Qualification and Precision Landing Modes
- Fleet Training Technologies (FleeT2)
- Fleet Adaptive Multilevel Measurement for Operations & Unit Systems (FAM2OUS)

MISSION

Conduct Research and Development to support the design and development of training programs and instructional tools through application of advanced technologies, training effectiveness evaluations and human-computer interface design.

EXPERTISE

Research Psychologists (B.S./M.A./ Ph.D.'s)

- Applied Experimental
- Human Factors
- Industrial/Organizational
- Modeling and Simulation

POINTS OF CONTACT

Heather Priest, Lab Lead
Dr. Randolph Astwood, Lab Manager

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STRIKE LAB
Simulation and Training Research to Improve Knowledge and Effectiveness

MISSION

Apply cognitive science and human factors engineering to improve warfighter readiness through optimal training and system design. Perform research to improve the instruction implemented in training systems in order to maximize learning and/or performance.

EXPERTISE

- Human Factors
- Cognitive Science
- Experimental Design
- Statistical Analyses
- Adaptive Training
- VR/AR/MR
- Individual Differences
- Training Effectiveness Evaluations
- User Interface Design
- Usability Testing

POINTS OF CONTACT

Wendi Van Buskirk, Lab Lead
Rosemary Garris, Lab Manager

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CAPABILITIES

- **Adaptive training (AT) system design and development.** We utilize cognitive theories and science-based principles to guide all aspects of AT development including task analyses, performance metrics, user interface design, assessment algorithms, instructional adaptation algorithms instructional content (including scenario development), & iterative system evaluations.
- **Instructional strategies research** aimed at understanding which instructional techniques work best for the particular task and for the individual trainee in order to optimize learning. For example, we perform basic research on the type, timing, content, valence, and modality of feedback, scaffolding, hinting/cueing, and individual differences.
- **Application of advanced technologies in training systems** including virtual and augmented reality, game-based training, and human behavioral modeling in scenario-based training systems. We seek to understand how and when to incorporate these advanced technologies in our training systems to improve learning outcomes and efficiency. Our perspective is to instantiate these technologies in a thoughtful way to maximize our return on investment rather than incorporating technology for technology's sake.
- **Training effectiveness evaluations** aimed at quantifying learning and/or performance improvements gained from the training systems we developed. We emphasize robust data collection efforts in order to assess short-term or long-term transfer and/or knowledge retention in addition to user reactions data. This approach allow Fleet decision-makers and stakeholders to make evidence-based determinations regarding the successful implementation of our training approaches.
- **User interface design and usability testing** including both formative and summative techniques such as use cases, focus groups, heuristic evaluations, usability studies, science-based and/or data-driven design & re-design recommendations.

TRANSITIONED RESEARCH PRODUCTS

Submarine Electronic Warfare Adaptive Training System (SEW-AT)

Periscope Operator Adaptive Training System + (POAT+)

Technology Research Applications Team (TechRAT) Laboratory

CAPABILITIES

- **Software Application Development** including individual and team training simulations, replay and after action review, mobile applications, scenario authoring tools, image generators, emulations of tactical and commercial equipment, and gaming area authoring tools.
- **Turnkey Training System Design and Production** including proof of concept, rapid prototypes, limited quantity productions, and life-cycle extension upgrades.
- **2D/3D/VR Virtual Tours** including panoramic photography-based virtual tours, 3D rendered virtual tours, and virtual reality tours. Virtual tours provide familiarization and procedural training, interactive courseware, and embedded media files.
- **Research Testbed Design and Development** to facilitate research activities including data collection, usability studies, adaptive training, and haptic device investigation.
- **Reality Capture** including 3D laser scans, photo references, 360° video references, wearable and optical motion capture.
- **Building Virtual Environments** from source material including: Computer Aided Design (CAD), 3D point clouds, photogrammetry, and traditional modeling.
- **Integrating with External Systems** including stimulating commercial and tactical hardware and software and implementing training network protocols.

TOOLS

- Unity 3D
- Visual Studio, Team Foundation, Perforce
- 3D Studio Max, Allegorithmic Substance Designer
- Computer Aided Design (CAD) and Manufacturing (CAM)
- Small and Medium Scale Fused Deposition Modeling (FDM)
- 3D Laser scanner
- 360° video camera
- OptiTrack visual motion tracking system

MISSION

Provide simulation and media solutions for the naval aviation, undersea warfare, surface warfare, and special warfare training communities.

EXPERTISE

- Modeling and Simulation
- Extended Reality Systems
- Rapid Design and Production
- Agile Software Development
- Computer Science
- Navigation Training
- Haptic Data Gloves
- Mobile Technology
- Adaptive Training

POINTS OF CONTACT

Kenneth Hadden, Lab Lead
Rosemary Garris, Lab Manager

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Trident Training System (TTS) Laboratory

MISSION

Provide full trainer life cycle support for the Trident Submarine Damage Control Trainer and the Electrolytic Oxygen Generator / Automated Electrolytic Oxygen Generator Simulator (EOG/ AEOG) training systems. The lab manages software/systems development, integration test, design, packaging, and fielded updates. It uses an integrated development environment and modular test berth to perform these trainer support functions.

EXPERTISE

- Modeling and Simulation
- Electromechanical Systems
- Software Development
- Rapid Design and Production
- Hardware/Software Integration

POINTS OF CONTACT

Leland Johnson, Lab Lead
Leticia Izquierdo, Lab Manager

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CAPABILITIES

- **Turnkey Training System and Technology Design and Production** including proof of concepts, rapid prototypes, limited quantity productions, and life-cycle extension upgrades.
- **Software Application Development (EOG/AEOG)-**Implements automatic shutdown logic. Simulates operational status and annunciation displays. Implements cursor selectable simulation options via the displays. Implements sequential steps of operational procedures as they are selected . Detects and annunciates operator errors. Simulates cell liquid levels. Simulates effects of manual overrides of solenoid valves and pressure control valves. Simulates oxygen pressure and differential pressure (DP) regulator control loops.
- **Electronics Design and Fabrication** including circuit design, prototype and small-quantity circuit board production, wired and wireless interfaces, firmware development, device fabrication and assembly, and production of electronic test equipment suites.
- **Mechanical Design and Fabrication** including part and assembly design, electro-mechanical and -optical devices, pneumatic systems, and fabrication using a variety of materials (plastics, non-ferrous metals, stainless steels). Additive and subtractive manufacturing process are supported for both prototype and low rate production.

TOOLS

- Electrolytic Oxygen Generator Front Panel Simulator
- CITECT Software
- Peripheral Component Interconnect (PCI) eXtensions for Instrumentation (PXI) architecture.
- LabVIEW

TECHNOLOGY TRANSFER (T2)

The NAWCTSD Technology Transfer Program operates under the auspices of the Federal Technology Transfer Act, related laws, executive orders, directives, and guidance. The anticipated benefits of sharing the results of Navy modeling, simulation, training, and human performance research and development (R&D) with public and private research organizations are: improved national, state, and local training and education, new commercial products and additional national employment opportunities, access to Federal Government subject matter experts (SME) and resources, and feedback on R&D products that can be used to improve future Government systems.

Federal technology transfer has been in place since 1980 to facilitate the transfer of federally developed technologies to the private sector as well as academic institutions and state and local governments. Federal and non-federal partners have the opportunity to work together on mutually beneficial research and development using instruments called Cooperative Research and Development Agreements or CRADAs. Technology transfer legislation also promotes the licensing of inventions/patented technologies developed in federal laboratories for commercial applications. Through technology transfer, the nation's investment in federal research and development leads to products, services, and capabilities for the good of the public.

The objective of the NAWCTSD Technology Transfer Program is to increase the development of partnerships with both the public and private sectors in order to share the cost, development, and application of technologies, and to foster development of commercial sources for NAWCTSD technologies/ innovations. This is accomplished through technology transfer vehicles such as CRADAs, Commercial Services Agreements, Licensing Agreements, and Education Partnership Agreements with academia, industry, and state and local governments. Agreements such as CRADAs can provide a vehicle for NAWCTSD to receive feedback on, and to further develop, R&D products, which can be used to improve future systems. NAWCTSD also partners with other Federal Government agencies through Interagency Agreements.

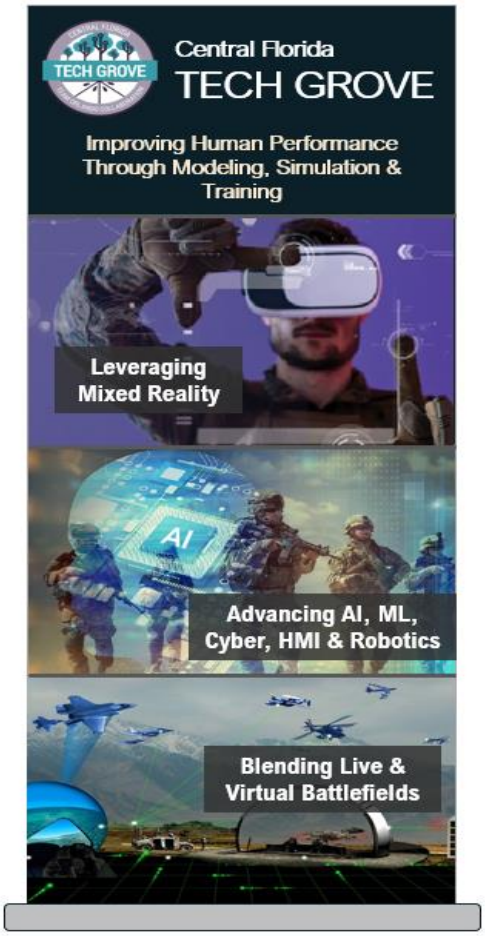
There are benefits to the public from the exchange of knowledge and products within the Government. Exchange includes sharing information and products with other federal agencies, as well as with state and local governments. By sharing knowledge and products on a wide basis, the public reaps the benefits from research conducted for one purpose or agency in many new ways. The return on the investment of the tax dollar is increased.

Another benefit of Federal Technology Transfer legislation has been the establishment of the Federal Laboratory Consortium (FLC). This consortium is a network of more than 700 federal laboratories and research centers. The FLC provides a nationwide laboratory forum to develop strategies and opportunities for linking federal laboratory technologies and expertise with the marketplace. NAWCTSD is a voting member of the FLC.

The technologies/products/services described in this Technology Transfer section offer opportunities for partnerships with NAWCTSD through CRADAs or licensing agreements. For more information, please send an email to:

ORLO_PDRT@navy.mil.

CENTRAL FLORIDA TECH BRIDGE AND THE TECH GROVE



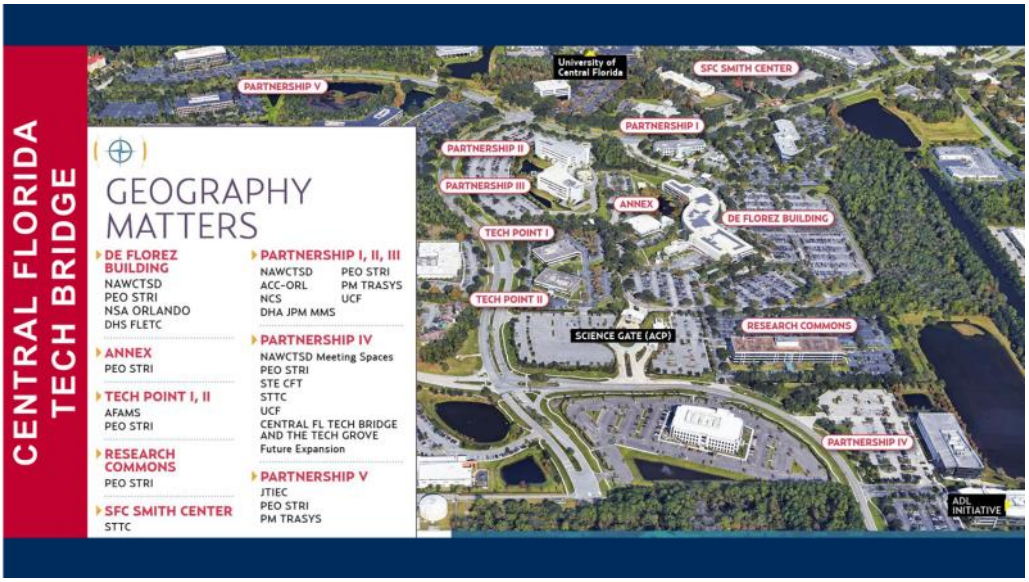
Take a Tour and Get Connected:

https://www.secnav.navy.mil/agility/Pages/

NavalX was established in Feb 2019 as an initiative of the Assistant Secretary of the Navy for Research, Development, and Acquisition to serve as the Dept. of Navy (DON) workforce "super-connector," focused on scaling non-traditional agility methods across the DON workforce.

Central Florida Tech Bridge facilitates collaboration, innovation, and exploration between Small Businesses, Entrepreneurs, Labs, Academia Team Orlando, and Government Stakeholders.

Tech Grove Tech Grove is an innovation center created in partnership with University of Central Florida Research Foundation (UCFRF) to foster collaboration and the acceleration of novel, non-traditional, Modeling, Simulation, Training & Human Performance solutions to our national defense partners at Team Orlando. https://www.centralfloridatechgrove.org/



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